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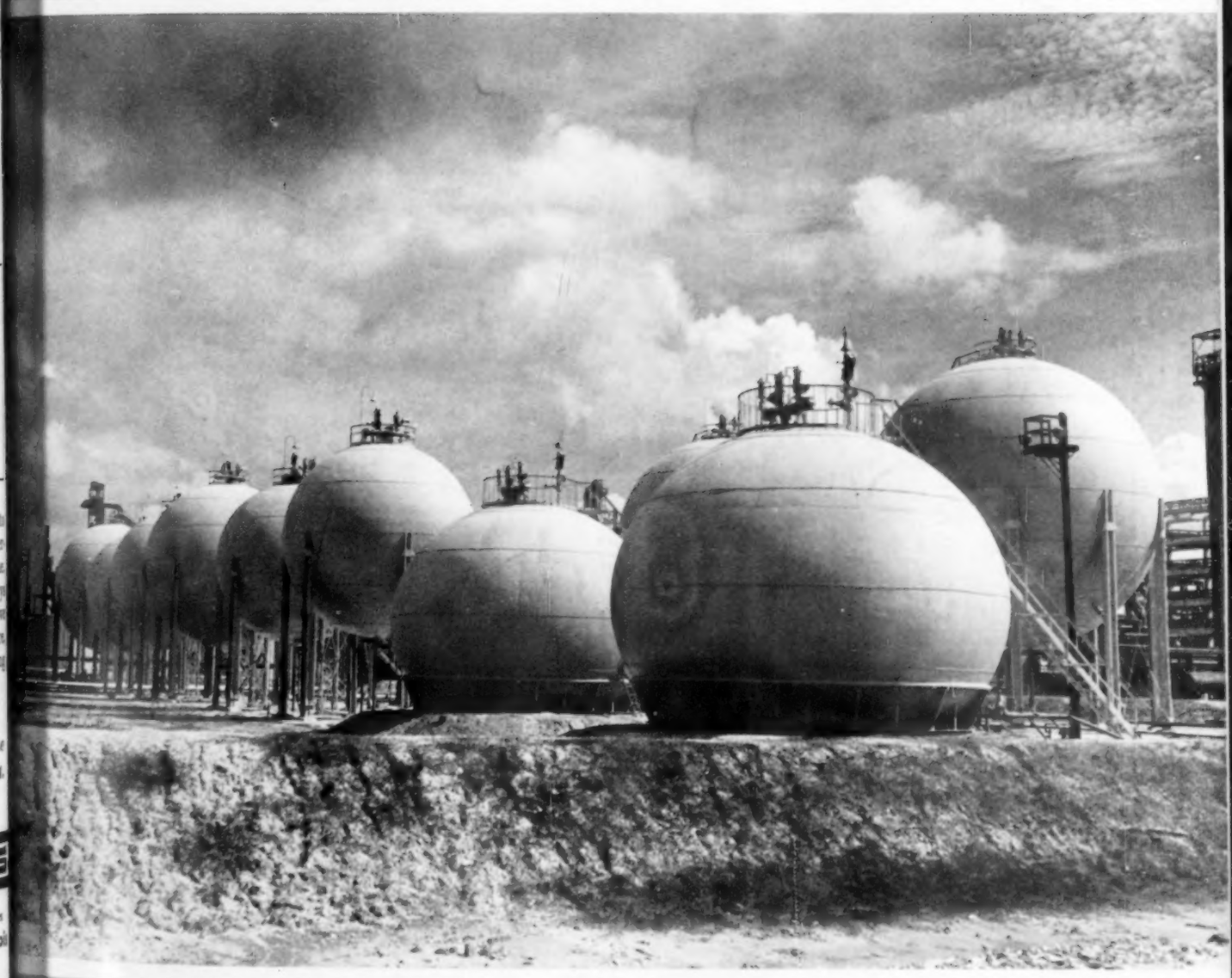
The WELDING Journal



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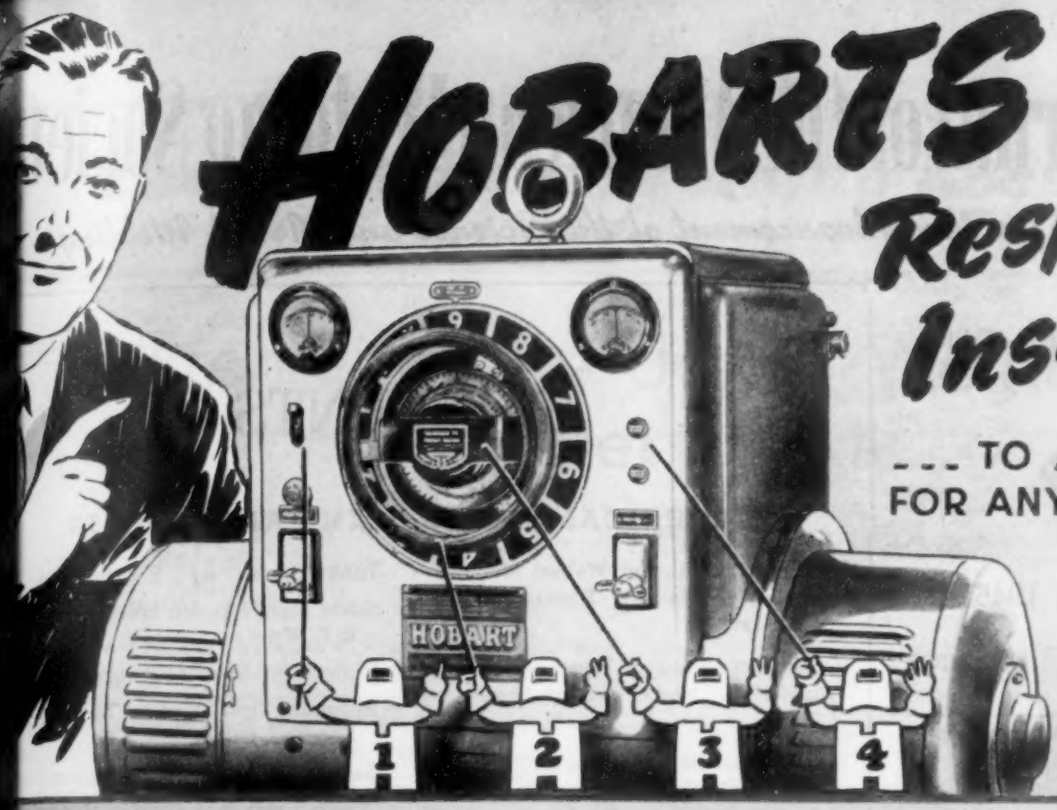

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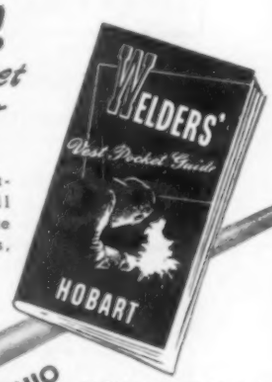

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Published for the Advancement of the Science and Art of Welding

W. SPRARAGEN, Editor

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COVER

The Cities Service Refining Corporation's New 100-Octane Gasoline and Butadiene Plants at Lake Charles, La. *Courtesy Chicago Bridge & Iron Company*

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Trends in the Use of Welded Machinery Parts*

By Edward J. Charlton†

THIS discussion of trends in the use of welded machinery parts will be limited to components fabricated from low-carbon hot-rolled steel and its related alloys. The topic is timely, for the use of welded machinery parts is about to enter what is perhaps the most important stage in its growth. As a broad and fundamental trend, this use over a period of roughly 15 years since its inception has gained the status of general acceptance for welded machinery parts.

If it can be said that the utilization of this new type of construction has aided our war effort, we can be thankful that service records in many prior applications proved the effectiveness of weldments. Not only have these records served to prove the adequacy and engineering value of welded machinery parts but also from these service records in diverse fields, certain convictions or assumptions in design philosophy have been substantiated, particularly under operating conditions embracing fatigue and impact.

One weldery alone dating from 1930 has produced or collaborated in the design of welded steel machinery parts for nearly 700 different users in 15 industries. These parts have gone into service in 28 states as well as in foreign lands.

The basic impetus behind this general acceptance can be divided into two parts: one, economic; the other, engineering.

An additional impetus during the war years has been an abnormal urgency of acquiring necessary parts by any means, as quickly as possible, with the result that many times, normal economic justification must have been nonexistent. Doubtless the spread in use of fabricated parts has been accelerated simply because trial samples or educational designs embodied them. During the war period great quantities of duplicate weldments have

* Contributed by the Metals Engineering Division for presentation at the Annual Meeting, New York, N. Y., Nov. 27 to Dec. 1, 1944, of The American Society of Mechanical Engineers.

† Assistant to President, Lukenweld, Inc., Division of Lukens Steel Co., Coatesville, Pa.

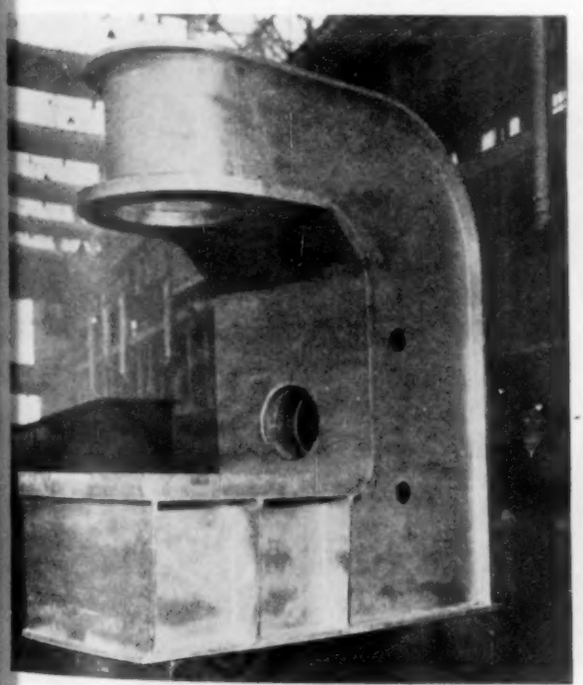


Fig. 1—Housing for a 255-Ton Joggling Press Used for Crimping Edges of Plates. This Housing Measures 10 Ft. 8 In. Long x 4 Ft. 8 In. Wide x 11 Ft. 6 In. High and Weighs 33,040 Lb.

Fig. 2—A Gear Housing, a Weldment Produced by the Hundreds. The Weldment Is Justified Because of Its Higher Degree of Predictability, on Its Reduction in Repair Time, Over Former Type of Construction

been fabricated, while under normal conditions the investment necessary for plants, tooling and other equipment to produce these parts might have awaited economic justification.

Welderies Have Developed Industrially

Hence, we will enter the postwar period with existing welderies taking definite forms as industrial units scattered throughout the nation, with many of them devoted exclusively to production of machinery parts. Already some have developed as subsidiaries supplying parts to plants producing finished machinery. Others have developed as an outgrowth of plants previously engaged in other types of fabrication. Still a third group has specialized solely in the production of welded machinery parts. Such growth and development is in contrast to that of the foundry industry.

It is impossible to discuss this subject of welded parts practically, without contrasting its aspects often with those of the foundry industry, because structural parts of machinery traditionally have been castings. However, no implication is intended in this article that a struggle between the foundry and the weldery should exist.

Drawing a comparison with the foundry industry, we see the use of cast iron growing steadily in step with the progressive mechanization of industry. Cast steel entered the field as a material vastly superior in its physical properties to any then existing iron. The steel foundry clearly is a child of necessity.

By contrast, the use of welded parts was inaugurated with no clear-cut apparent general necessity. Traditional media for producing structural mechanical parts did exist. Hence relatively fine lines of distinction from standpoints of economics and engineering had to be developed. These distinctions were established on the design philosophy of full utilization of the superior properties of rolled steel with the result that an engineering service has developed of necessity as a part of this new industry.

That future trends in the use of welded machinery parts will be based on well-equipped existing welderies is a fairly drawn conclusion, and they will compete in every legitimate means to maintain themselves. War-time production will affect these trends by providing broad statistical service records which have been made under most drastic conditions imaginable. Basic cost data will be available in addition to existing experience in design, methods and quantity tooling. This accelerated development can be compared with prewar conditions, when contracts covered small quantities. In these years, the complete exploitation of the process by production tooling was not justified.

On the other hand, undoubtedly much misuse of weldments has resulted because of war necessity. Instances of their application because of scarcity of other materials must exist. Criteria established by battle damage possibly has introduced the use of weldments in applications not justified commercially. Inevitably with respect to such applications the trend will be toward reversion to the use of castings.

Without doubt certain changes in design criteria are due, for weldments have been applied to machines, the over-all design of which was frozen for one reason or another. Possible superior advantages have been submerged in such applications. Unless the machines are redesigned to realize the full value of welded construction reversion might occur.

Basic Reasons for Trends

Several fundamental basic reasons for normal trends in the use of welded parts apply to the selection of any engineering material and they reflect either economic or engineering concepts or a combination of the two. These reasons are: comparative first cost, predictability, strength characteristics, need for greater rigidity, weight reduction, wearability, operating efficiency and natural adaptability.

These factors determine the selection of a material or process, and usually one of them dominates, with the others as lesser influences.

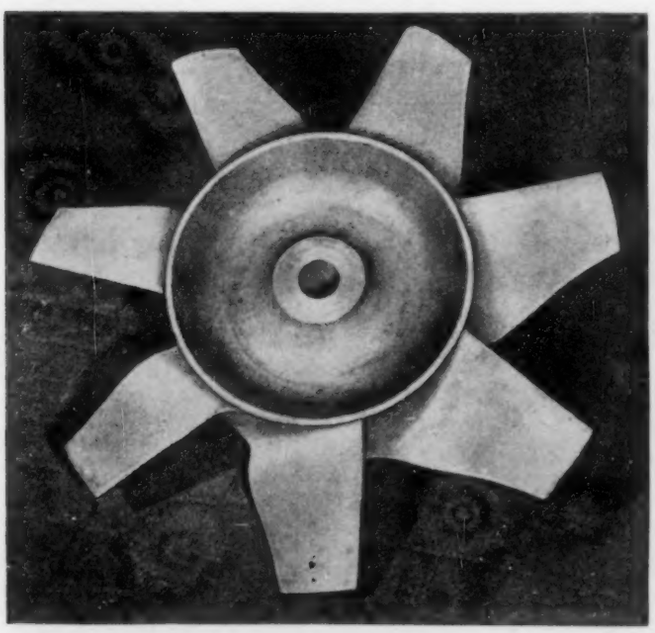


Fig. 3—High-Speed Blower Fan, Composed of Central Forging with Forged Vanes Welded to It. These Fans Operate at 5000 Rpm. and Are Tested at 7500

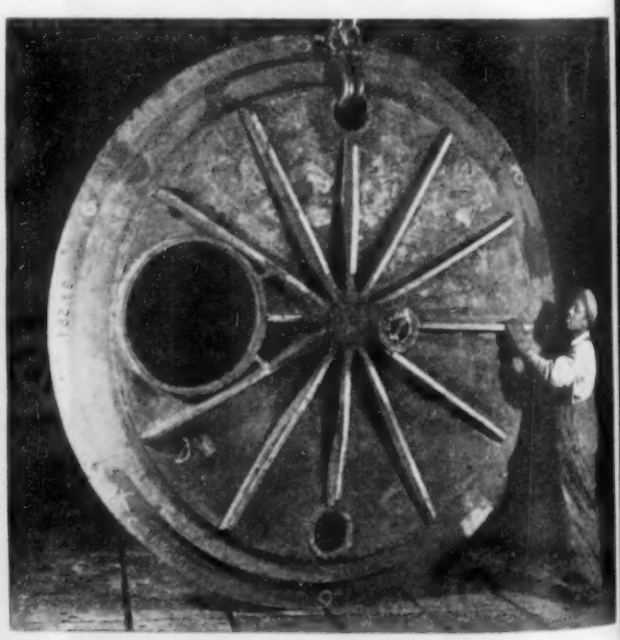


Fig. 4—End Portion of Rotary Mixing Unit in a Chemical Process, Which Is in Continual Operation. The Central, or Hub Section, and the Rim Are of Cast Steel. The Rest of the Construction Is Steel Plate. The Head Is 9 Ft. 8 1/2 In. O.D. and Weighs About 6000 Lb.

Cost Is Fundamental

Comparative initial cost is the first on our list of reasons.

If the design is adequate . . . if it is economical . . . if possible indirect economies have been considered in cost comparisons . . . if the specifications are clear and conclusive . . . this fundamental reason loses its engineering significance. It becomes purely an economic consideration and a function of the Purchasing Department.

Predictability Is Insurance

The second of our reasons is predictability. This can be a matter of insurance as in the open side press frame, Fig. 1. This weldment replaced a fractured cast frame in an existing press which had been in operation for a relatively short time. It was installed several years prior to the war.

Such insurance is an economic reason justifying the use of a new type of structure. If the first cost of the weldment exceeded that of the casting, the premium can be considered as that on an insurance policy against failure. Machining, installation and loss of production while the replacement was being built also are cost factors. An obvious trend exists here since weldments are being widely used in such heavy machinery.

Another item involving predictability is rejection or scrappage. We have a small item, Fig. 2, which has been produced by the hundreds. It is hard to conceive that its first cost could compete with that of a casting. The use of this weldment stems from the alleged expenditure of an average of 75 hours for repair on each such casting. This may seem an exaggeration, but on the other hand, it may not since magnaflux was used as an inspection method on both casting and weldment. At any rate, the user of this part apparently feels that a weldment is justified because of its higher degree of predictability.

The weldery cannot be held responsible for "stealing" this item from the steel foundry since the user was about to substitute bronze when the weldment entered the picture.

A report on the repair time states that the alleged 75 hours previously necessary have been reduced to one or two hours on the weldment.

Another element, relatively unimportant in predictability, is that on large pieces, less metal need be removed in machining. Personally I have seen $^3/_4$- to 1-in. stock being machined from steel castings of large dimensions. Yet weldments of such size can be produced with an allowance of $^3/_8$ in.

All these factors involving predictability in the trend of weldment use have only economic significance.

A factor of engineering significance is consistent predictability required by severe operating conditions. This high-speed blower fan, Fig. 3, is composed of a central forging with drop-forged vanes welded to it. These fans which operate at 5000 rpm., and are tested at 7500, have been used for several years prior to the war.

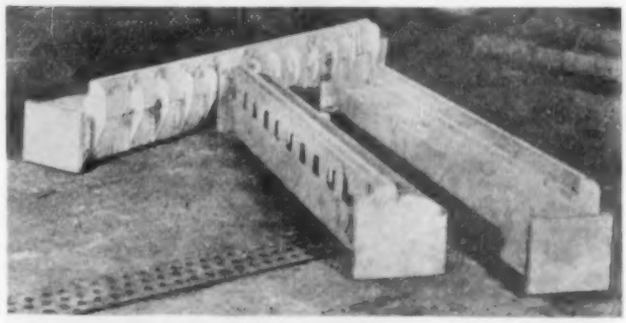
Obviously the inherent soundness of the forged and welded steel is considered insurance against failure which would be very serious at the speeds indicated.

Comparative Strength Characteristics

The third reason behind the trends which we are discussing is the comparative strength characteristics of competing materials.

Figure 4 shows the end portion of a rotary mixing unit, many of which are in operation in a chemical process. The original design used steel castings and properly so, for at that time weldments as machinery parts did not warrant consideration since too little was known about their design. The castings failed consecutively following a limited service life. Repairs were attempted unsuccessfully so that replacement became a somewhat normal procedure. The difficulties of shape and size limitations apparently were such that a steel casting of designed strength was not possible.

Fig. 5—Knife Beam of Welded Steel, Which Moves at High Speed in a Reciprocating Motion. It Is About 7 Ft. 0 In. Long with a Cross Section Approximating 8 x 9 In., and with Walls $^1/_{16}$ In. Thick



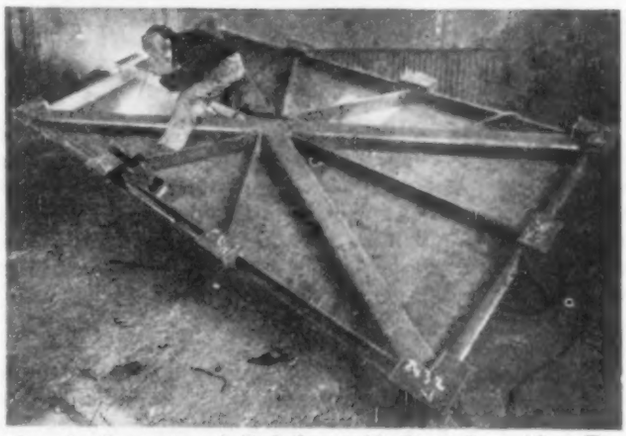


Fig. 6—Conventional Bed for a Machine Assembly. The Primary Members of Underside Stiffener Diagonals Are Closed Box Sections

Finally, attempting to eliminate constant replacement, the user considered a weldment. The piece shown is the result which has now become standard in this application. The original installation has been in service for over five years and no replacements have been necessary. No change in the mechanical design was needed; the weldment simply replaces the casting within the size and clearance limitations imposed.

A substantial part of the welded structure remains a steel casting. Castings were used in the design where economical, as well as to obtain flowing contour inherent in a casting at points where such is desirable.

We have here a profound difference in the concept of applying castings. The castings used in this part are of such size and shape as to be desirable and readily produced in the foundry. This is in contrast to the difficult production features of the entire piece as a single casting.

Two things are apparent here in connection with comparative strength characteristics. First, steel plate has been substituted in the large flat expanses involved and secondly, the concept of welding has permitted the elimination of the fundamentally weak points. The piece is broken into small components of predictable strength; integrated with welds of predictable strength.

In such a mechanical part, a comparison of physical properties applicable to static loading conditions is not adequate. Repetitive and reversed loading occurs, and the endurance limit of the structure becomes the controlling criterion. There is a trend toward making the endurance limit and impact resistance definitely specified properties of materials to be used in the structural parts of machines.

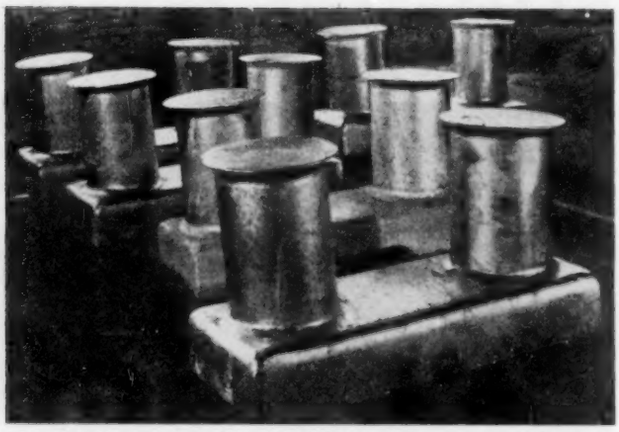


Fig. 7—Mooring Bitts Used for Maritime Purposes. The Parts Were Pressed and the Pipe Assembled and Welded to the Tops and the Bases

Much has yet to be established by research, regarding such properties. Our knowledge regarding phenomena resulting from multiaxial stresses is limited also. However, the progressive accumulation of such knowledge will promote meticulous care in design and production so that present-day castings or weldments will seem crude in shape and quality by comparison.

Maximum Rigidity Considered

Our fourth reason behind the trends in the use of weldments is maximum rigidity and this must be considered within definite weight and space limitations to be discussed clearly.

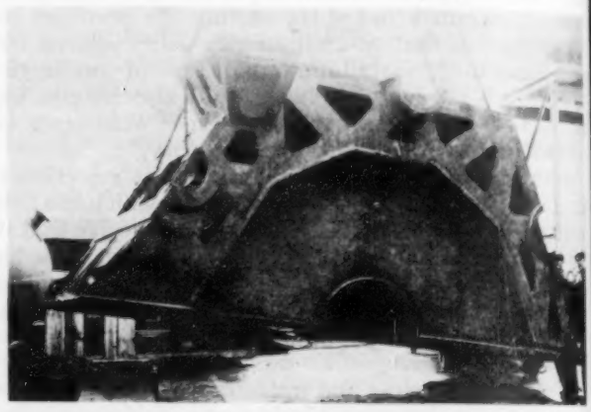
Maximum rigidity so limited, obviously can be realized only by disposing material with the highest possible modulus of elasticity in the most effective manner. Simply put, there is no question that an iron casting is more rigid if it weighs enough or is sufficiently larger in cross section.

The foregoing remarks may seem elementary, but they are made because the repeated assertion in the early days of welded steel, that cast iron is stiffer, is still heard occasionally.

The welded part shown in Fig. 5 was redesigned into welded steel many years ago. It is about 7 ft. long with an approximate cross section of 8 x 9 in. In welded steel its walls are $^{3}/_{16}$ in. thick. Clearly with such thinness it is lighter in weight than any design possible as a casting. Its function demands maximum rigidity, but minimum weight is desirable also. It moves at high speed in a reciprocating motion.

Fulfillment to a higher degree of the necessities just mentioned was provided by the weldment and greater operating efficiency resulted.

Fig. 9—Upper Case for Housing Speed Reducing Gears, of All-Welded Steel Construction That Weighs 42,000 Lb. and Is 18 Ft. 6 In. Wide x 8 Ft. 8 In. Long x 7 Ft. $10^{5}/_{16}$ In. High



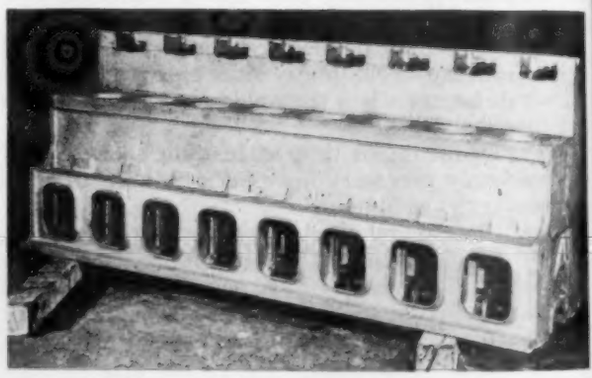


Fig. 10—Frame for Eight-Cylinder Engine. This Frame Measures 6 Ft. 10 In. Long x 2 Ft. 7 In. Wide x 2 Ft. 0 In. High, and Weighs Approximately 2065 Lb.

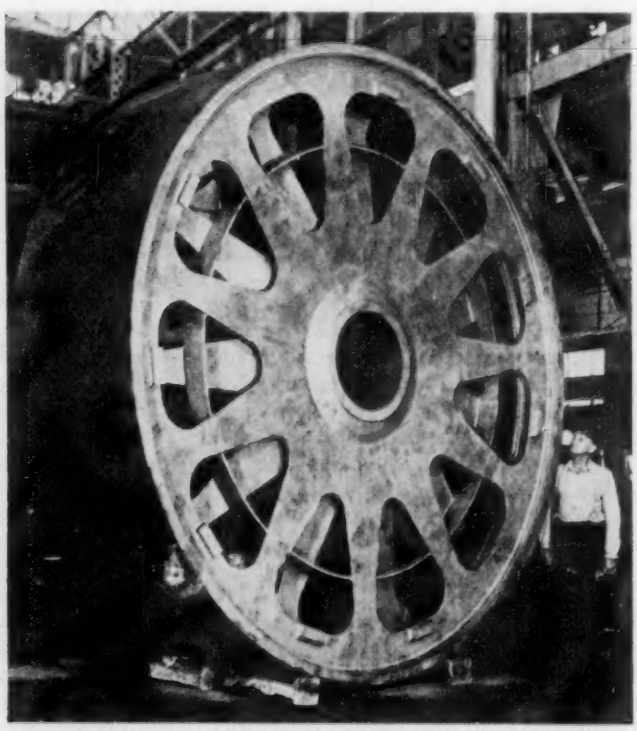


Fig. 8—Second Reduction Gear Blank. This Gear Blank Weighs 25,000 Lb., Measures 12 Ft. $11^{1}/_{4}$ In. O.D. It Has a 3 Ft. $4^{3}/_{4}$ In. Face

Figure 6 is a conventional bed for a machine assembly. Since its over-all depth is limited, the user sought maximum rigidity within this restriction. The maximum is provided therefore within the extent of our knowledge of materials by steel disposed in an effective manner. The stiffeners on its underside are diagonal, and the primary members are closed box sections. The thickness of metal is dictated only by design considerations.

Weight Reduction

Our fifth reason in the selection of a structural part is weight reduction. This reason has established to a great degree the trend in the use of weldments. Weight is a watchword in transportation equipment with current emphasis on increased speed, safety and operating efficiency.

The item shown in Fig. 7 is typical of many relatively unimportant or prosaic fittings applied on the decks of

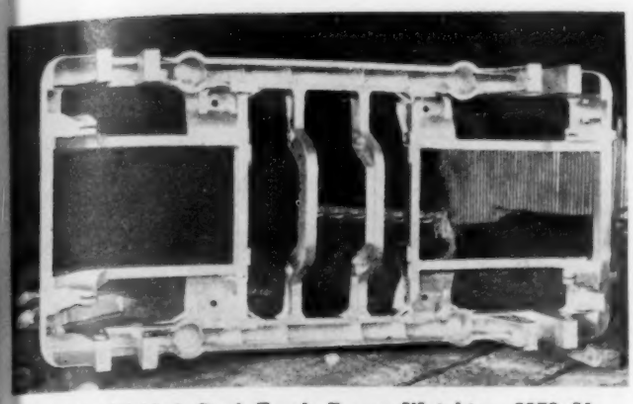


Fig. 11—Welded Steel Truck Frame Weighing 3950 Lb. The Over-all Dimensions of the Frame Are 15 Ft. 0 In. Long x 7 Ft. 6 In. Wide x 2 Ft. 3 In. High

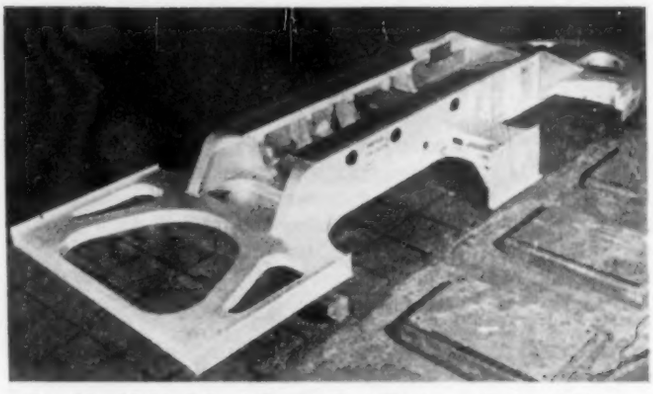


Fig. 12—Welded Steel Engine Bed Used on a Railroad Motive Power Unit. The Completed Engine Bed, Weighing 3 Tons, Supports 30 Tons of Load

maritime vessels of all types. Traditionally, they were castings of greater over-all weight. If they can be produced as castings at equal weight they will revert ultimately if prices are competitive.

Of the two items shown in Figs. 8 and 9 the one in Fig. 8 is a gear blank, the other in Fig. 9 a housing of the same mechanism, both of which came into being in the search for minimum weight. They were used first as structural parts of marine drives on naval vessels in the days when "treaty limits" were the design basis for our Navy's ships. Such items replace castings of relatively enormous weight.

Apparently they show marked superiority in resisting the abnormal loads imposed by the explosives forces of battle damage, but they are used extensively in cargo vessels also.

Weight reduction dictates the engineering selection of construction for this Diesel engine frame, Fig. 10. This frame is more complicated than it appears. Much of it is composed of metal $^{3}/_{16}$ in. thick, and such thin sections throughout its structure connect with much heavier sections in a somewhat abrupt manner. There are labyrinths in its shape involving many small enclosed pockets. Clearly it would be difficult, if not impossible, to use any other known form of construction with less weight.

Thousands of these frames have been produced without question of predictability or design hazard. They are neither scrapped in production nor are they replaced due to service failure.

Another major form of transportation involving minimum weight in equipment is the railroad. Figure 11 shows a car truck frame fabricated mainly of hot-rolled plate of $^{3}/_{8}$- and $^{1}/_{2}$-in. thicknesses with a few steel castings included. The user feels that 30% has been saved in the weight of this frame.

Figure 12 is a much publicized and ancient item of welded construction in railroad service. It is the entire foundation—25 ft. long, 10 ft. wide with the greater part of its structure $^{1}/_{4}$ in. thick—of the front end of the Zephyr type, high-speed, lightweight trains.

It is inconceivable that such a structure in one piece could be obtained by any other known method at equal or less weight.

Wearability

Wearability, the sixth point mentioned as establishing trends in the use of weldments, is typified by the part pictured in Fig. 13. It is a plate 8 in. thick, 23 in. wide, and weighing 12 tons formed in the bending rolls to a 12-ft. circle and butt welded. After finishing, these weldments are used as "riding rings" on rotary kilns, as shown in Fig. 14. Wear naturally controls their service life, but they do not wear out as quickly as those previously used.

Increased Operating Efficiency

Our seventh reason is increased operating efficiency of the machine in which the parts are used.

The dryer roll, shown in Fig. 15, is an important advance in the use of welded machinery parts. It is a steam-heated dryer used in the paper, printing, drug and textile industries. Traditionally of cast iron, at least 250 welded steel dryers are now in use, some of them for more than 10 years. They are lighter in weight than castings, but this is not usually a prime consideration. In one application steam consumption was reduced approximately 40%, and yet production was increased.

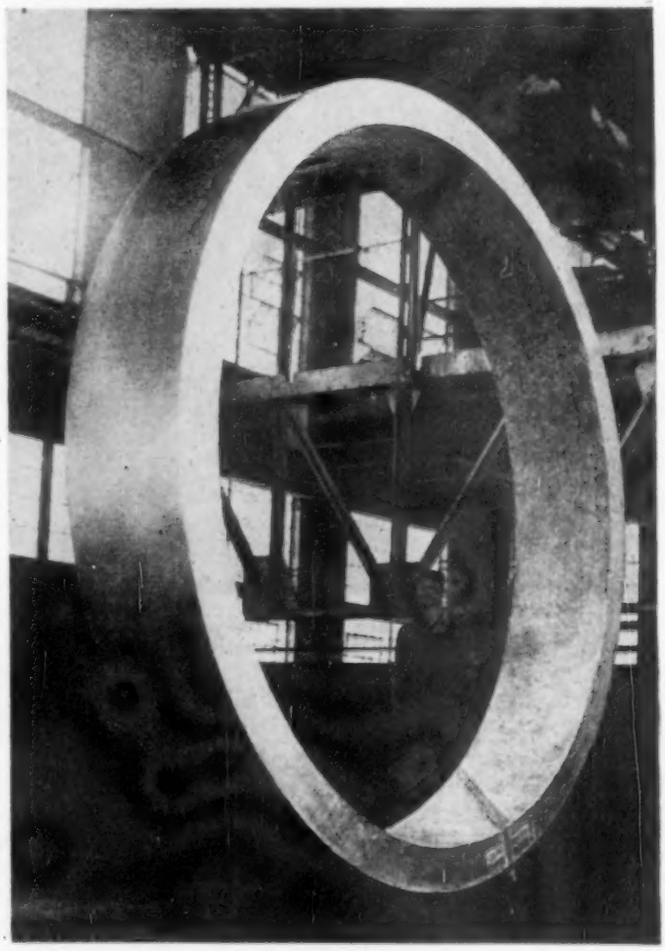


Fig. 13—Riding Ring Measuring 12 Ft. 0 In. O.D. x 10 Ft. 8 In. I.D. x 8 In. Thick and Weighing 12 Tons, for Use on a Rotary Kiln

The thickness of the outer shell on the dryer shown is approximately $^1/_2$ in. The dryer operates under a steam pressure of 100 lb. The replaced iron dryer, with much thicker shell, carried 20 lb. of steam.

In one application the weldment directly replaces a cast-iron dryer in a paper machine which was long in operation. Production was increased to a large extent because the initial drying capacity of the machine controlled its productivity. Since the installation of the weldment, another part of the machine has become the bottleneck.

Natural Adaptability

The final item establishing trends is natural adaptability—that is, the suitability of a welded structure to design requirements. In the foreground of Fig. 16 is a typical example of a beam weighing approximately 30 tons. Roughly it is 50 ft. long and 6 ft. high with flanges 5 in. thick, and web plates $^7/_8$ in. thick.

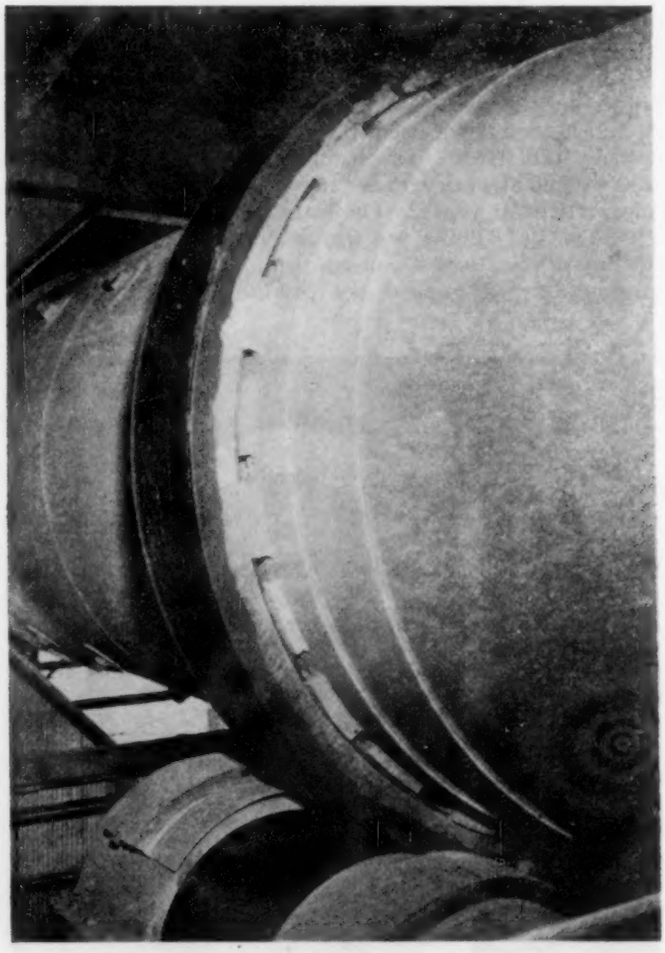


Fig. 14—Close-up of Riding Ring in Use as a "Tire" on the Kiln Showing Rollers on Which Ring Rides

It seems obvious that this form of construction is most suitable for parts of this nature. Clearly, riveted construction would not be more adaptable or economical. It is not likely that castings in either steel or iron would be more economical. Figure 17 shows this beam in use. The machine is a huge bending roll for the forming of large heavy plates.

Elementary Factors

In most applications the fundamentals of selection apply in combination. The foregoing eight examples are

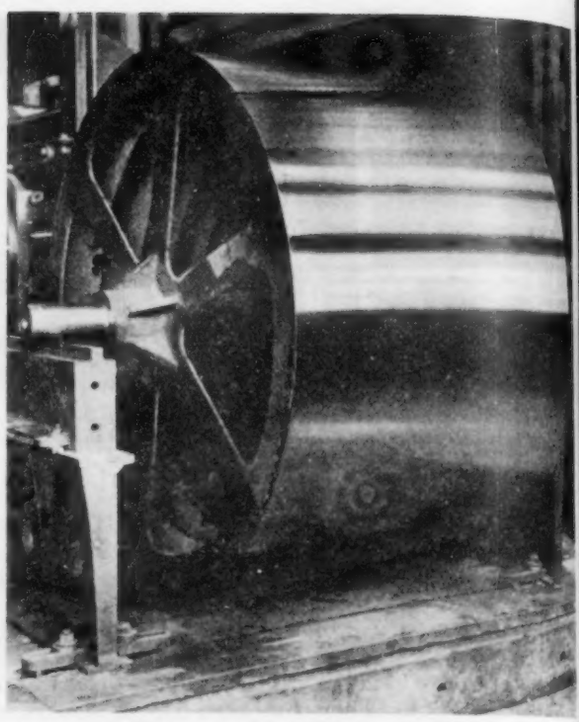


Fig. 15—Welded Steel Dryer Cylinder, Designed to Operate at 100 Lb. of Steam. Of the Double Shell Type, It Is 5 Ft. 0 In. O.D. and Has a 4 Ft. 0 In. Face. It Weighs 4665 Lb.

Fig. 16—Two of Three Welded Steel Girder Beams, One Top and One Bottom, for Use in the Construction of a Strongback Bending Roll, Shown in Fig. 17. In the Foreground Is a Bottom Girder 49 Ft. $8^1/_2$ In. Long x 5 Ft. $8^3/_4$ In. High x 2 Ft. 6 In. Wide, Weighing 57,980 Lb. The Top Girder, in Background, Is 40 Ft. 8 In. Long x 6 Ft. $0^3/_4$ In. High x 2 Ft. 6 In. Wide, Weighing 56,480 Lb.

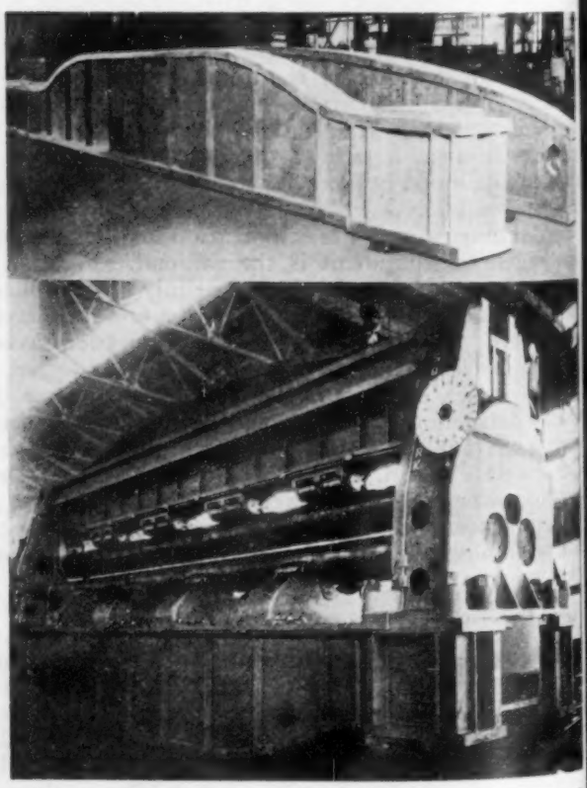


Fig. 17—Strongback Bending Roll Using 3 Girder Beams of Welded Construction, with a Screwdown Capacity of 2,400,000 Lb.

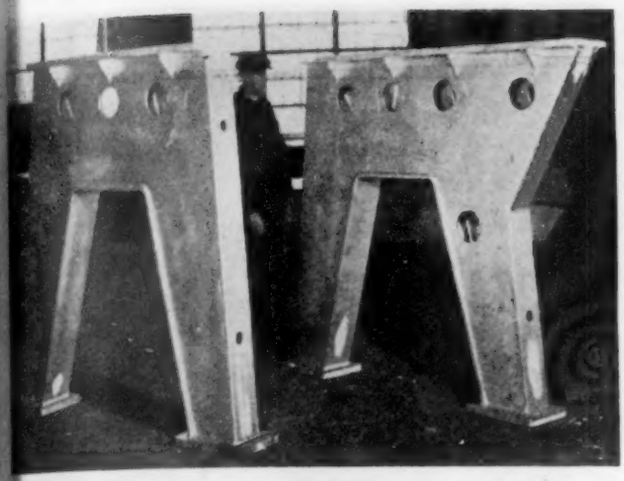


Fig. 18—Welded Steel Parts for Paper-Making Machinery

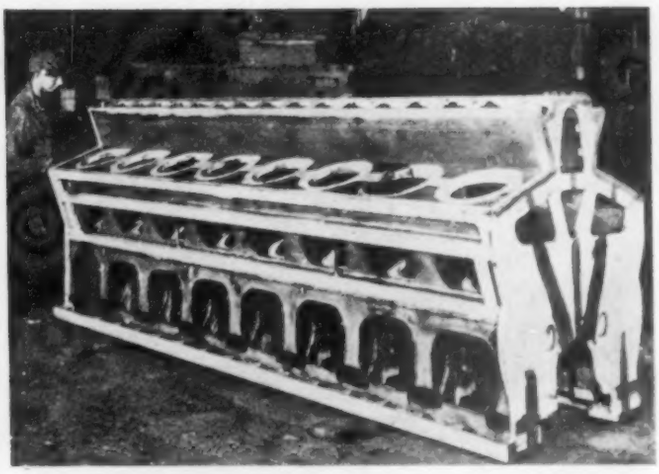


Fig. 19—Frame for 16-Cylinder Engine. This Frame Measures 11 Ft. 6 1/2 In. Long x 2 Ft. 11 In. Wide x 3 Ft. 7 1/4 In. High, and Weighs 8800 Lb.

intended to illustrate the predominance of the reason under which each was described. Many of the examples and much of this discussion are well known—possibly obsolete information. Our intention is not to add to fundamental knowledge in this discussion, but to pause at this point of impending industrial change and review these elementary factors behind the trends.

Developments excited by wartime considerations have been avoided deliberately in our instances. The prosaic examples that we have shown were selected, first, to illustrate the varied reasons for the current trends in the use of weldments, and secondly, to show the breadth and depth of their application in many industries.

Basic Fundamental Is Engineering

Certain engineering fundamentals underlie the use of any type of construction or material. The basic fundamental behind the trends in the use of weldments is the engineering utilization of rolled steel.

Such utilization may involve simple supports such as those in Fig. 18, or it may involve a relatively complex structure such as shown in Fig. 19.

Early weldments were considered practically as riveted structures. It was assumed that a welded joint was simply a joint. A pure butt weld was considered a hazard and structures were designed to eliminate them.

Electrodes, equipment and technique have developed progressively, so that today, a properly executed welded joint need not be regarded as a joint. A wide background of operating history substantiates this, for it is a recognized fundamental that a weldment when completed is not a number of separate components joined together, but a single, homogeneous piece of steel.

The material, of course, must be weldable.

Many types of carbon steel and its alloys are readily welded, but some require special care, involving for instance, pre-heating.

Field welding, or structural repair, must be taken into account in the selection of steel. Perhaps design loads are based on physicals dependent on special heat treatment. It is practically impossible to so treat the weldment in the field. Possibly the steel is not weldable at low temperature. Ordinarily these can be said to be considerations of little importance. They do apply in the selection of materials, for instance, in railroad service. In wrecks of minor nature structural parts must be readily repaired either by rewelding or straightening.

This is an instance of the type of thing considered in selecting materials for weldments, many other considerations exist.

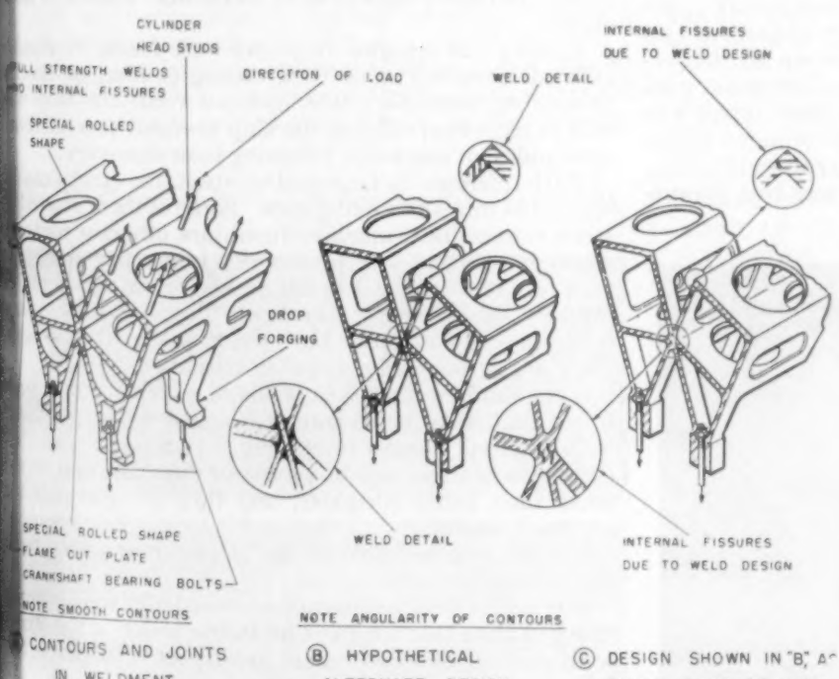

CYLINDER HEAD STUDS
FULL STRENGTH WELDS AND INTERNAL FISSURES
SPECIAL ROLLED SHAPE
DIRECTION OF LOAD
WELD DETAIL
INTERNAL FISSURES DUE TO WELD DESIGN
DROP FORGING
SPECIAL ROLLED SHAPE
FLAME CUT PLATE
CRANKSHAFT BEARING BOLTS
WELD DETAIL
INTERNAL FISSURES DUE TO WELD DESIGN
NOTE SMOOTH CONTOURS
(A) CONTOURS AND JOINTS IN WELDMENT
NOTE ANGULARITY OF CONTOURS
(B) HYPOTHETICAL ALTERNATE DESIGN
(C) DESIGN SHOWN IN "B" AS A SINGLE PIECE OF METAL

Fig. 20—Outlines of Primary Portion of Engine Frame Shown in Fig. 19, Illustrating Contours as Well as Positions and Types of Welds

Design Criteria Also Fundamental

The second fundamental is that of design criteria.

Naturally, the first of these is the type of service required of the structural part. The question of service requirements has been detailed in the eight basic reasons which we

Fig. 21—Production Stages of a Weldment Component. To Left Is Initial Billet; Next, Rough Shape Rolled from Billet; Third, Further Shaping by Flame Cutting; Fourth, Shape, Rough Machined to Required Dimensions

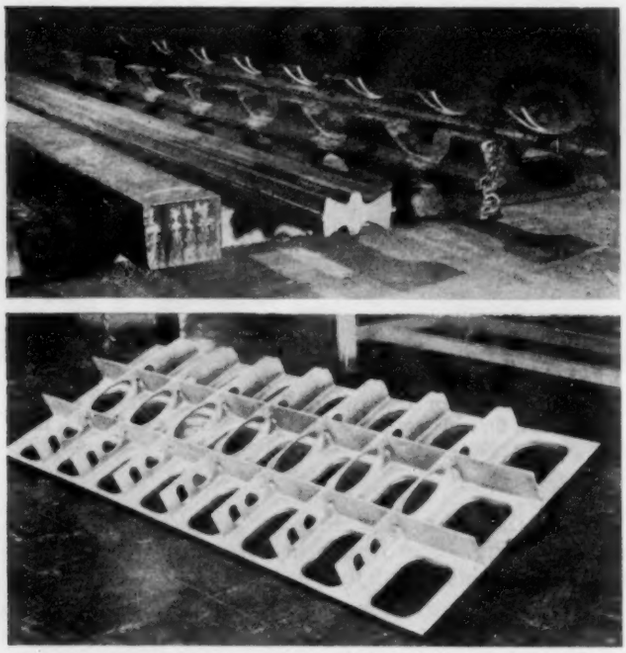


Fig. 22—Typical Subassembly, with Welding Completed as Shown, Accessible from the Standpoint of Welding and Inspection

have illustrated. However, we have an interesting specific example which involves many implications with regard to service requirements as a basic criterion of design.

Several years ago a submarine was commissioned powered by Diesel engines, the frames of which were of welded steel, similar to the one shown in Fig. 19. This vessel completed roughly 10,000 hours on these engines in normal service and from any standpoint the design of the engine frame had been proved satisfactory. Many hundreds of similar frames are in constant service today.

This particular submarine, however, has a very interesting history from the engineering standpoint. We hear that she was depth charged many times, on two occasions so drastically that she was blown to the surface. Ultimately the ship arrived on the West coast with known fractures in the engine frames. Some repair was executed at that time and she was then brought to the East coast under her own power for general overhauling.

The engines were dismantled completely this permitting detailed inspection with the result, the engine frames were replaced since many more fractures were discovered. To broaden the knowledge of design criteria, one of these fractured frames was returned to the fabricator for careful investigation. Location, type and possible causes of the fractures were studied and all surface cracks and every inch of weld metal were examined carefully.

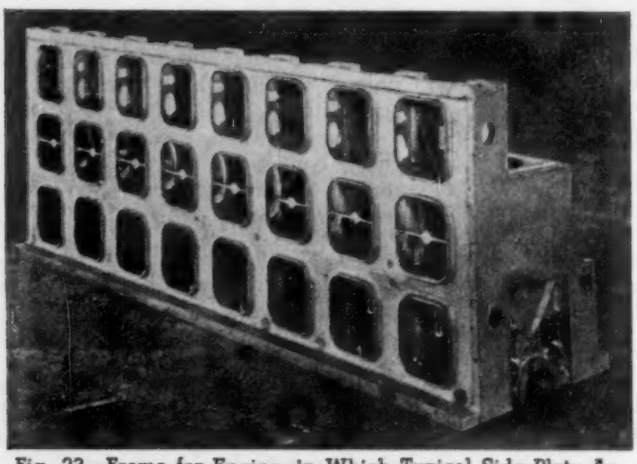


Fig. 23—Frame for Engine, in Which Typical Side Plate Assembly Shown in Fig. 22, Is Used

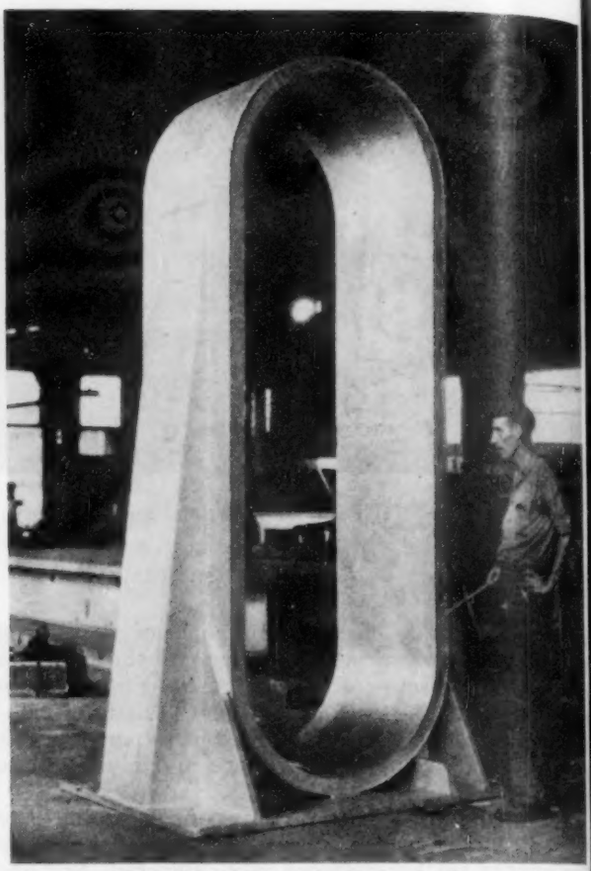


Fig. 24—Welded Steel Frame for Hydraulic Press of 2000 Tons Capacity. The Frame Consists of Two Steel Plates Formed in U-Shape and Joined by Butt Welding

Exactly 126 separate fractures were found—undoubtedly all occurred some time during combat or shortly thereafter, since they were noticed while the ship was still at sea—nevertheless the ship traveled several thousand miles, of necessity, following their discovery.

With reference to type and location, the cracks can be separated into a few categories. Some of them started at stress raisers due to machined contours, others at contours about openings. The profoundly interesting finding is that no failure started in the welds, or parent metal, of primary load-carrying members. Some of these members have two or more butt welds within their length. They are dynamically loaded in tension.

Some failures started in welds of secondary members, welds that were deliberately designed as simple fillets with internal fissures remaining. It was assumed that the stress in them was of a type or direction that would make such joints adequate, and they are adequate for normal operation.

Certain conclusions can be drawn reasonably from this service history:

One is that design criteria for normal operation is much different than that required for battle action, if the structural parts of the power plant are expected to survive the hull or other parts of the vessel.

Another conclusion is that a welded machinery part most definitely can be designed to withstand unusual and

Fig. 25—One of Two Halves Which Were Bolted Together to Form a Complete Throat Ring for a Turbine Unit at a Large Dam. The Throat Ring Measures 27 Ft. 6½ In. O.D. x 23 Ft. 0 In. 0.694 In. I.D. x 22 Ft. 0 In. at the top x 7 Ft. 11⅝ In. High, and Weighs 66,960 Lb.

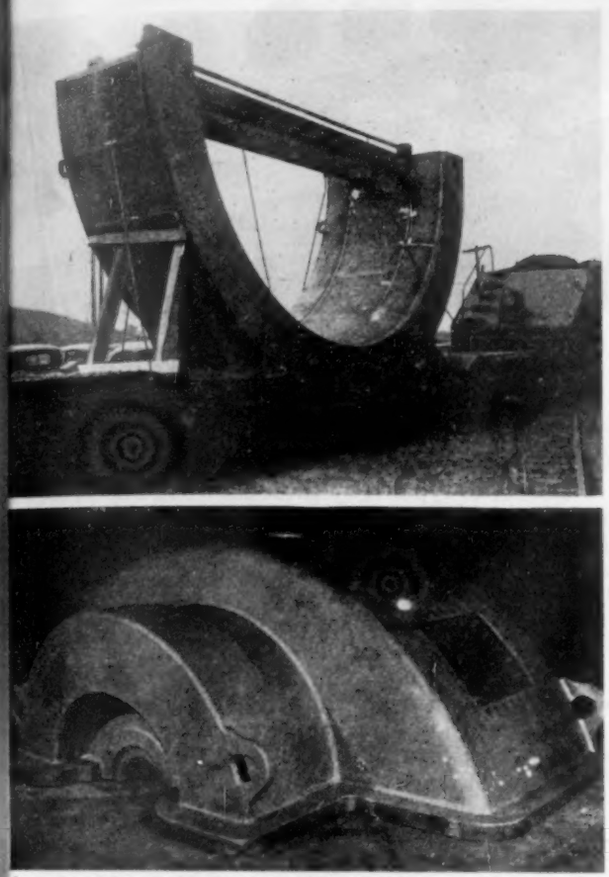


Fig. 26—Half of a Flanged Steel Head Is Used to Provide the Vertical Walls and Rounded Corners of the Main Portion of This Weldment. It Is Part of the Upper Housing for a Ship Turbine

indeterminate stresses. Those members and joints intended to carry maximum normal stress, survived the drastic shocks perfectly.

Some of the fractures starting at other points crossed over welds in primary members which substantiates the conclusion that a welded joint can be so designed and executed that it need not be regarded as such. Otherwise you would expect the fracture to follow such a weld once it found it.

Finally the frame was sufficiently rigid and structurally stable so that the severe shocks experienced still did not affect the operation of the engines. They brought the ship home!

Fig. 27—Component Part of Rear Axle Housing Shown in Fig. 28

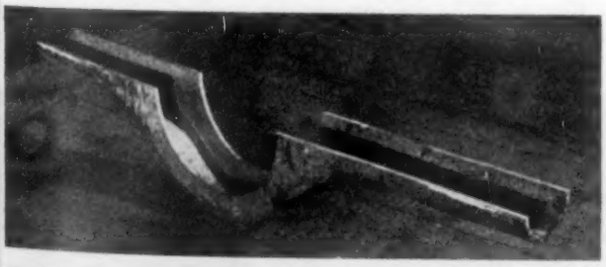


Fig. 28—Fabricated Rear Axle Housing

Metal Must Be Disposed Properly

If properties of the material are to be utilized efficiently the metal throughout the structure must be disposed properly. Where minimum weight or maximum rigidity are of prime importance, metal must be disposed so that design loads are carried with the most uniform stress throughout or with the maximum moment of inertia possible.

In Fig. 20, *A* is an outline of the primary portion of the engine frame just discussed. With regard to the disposition of metal, note the contours and the position of the welds. The frame could have been designed and built as shown at *B* and as a matter of fact many are so designed initially. Undoubtedly some have gone into service so designed at such points.

It is reasonable to assume that even though they survive normal service, abnormal service of drastic nature will cause failure. At any rate it is our conviction that such designs are utterly unpredictable and survive by good luck. This conviction is supported logically by the assumption illustrated in *C* where the same outline is shown as though it were a single piece of metal—which it is.

The internal voids shown exist to some degree unless the welds are made properly. Welds at such points in such a design are hard to make, and their X-ray inspection is difficult also.

If the section pictured in *C* were cast, it is a safe assumption that it would not be accepted with the fissures shown, yet many times such internal voids are designed into weldments.

Another point concerning proper disposition of metal is external contour. Flowing contours are natural to castings, the necessity being imposed by foundry requirements. They are necessary for another reason, too, in the structures of the type which we are discussing, because they provide relatively even stress levels; either designed or unpredictable. This logically is an absolute requirement for minimum weight and maximum serviceability.

Such design criteria cost money and there seems to be a natural tendency to just "weld" and hope for the best. Service records, however, substantiate our convictions on this score.

What is the economic comparison between first cost and minimum weight or predictable serviceability if these two things are definitely required?

Figure 21 shows the production stages of the component noted in the center of the left view in Fig 20, *A*.

On the left is the initial billet. Next we have the shape rolled from this billet. Following this the part is further shaped to the desired contour by flame cutting on a multiple torch machine. Finally the piece is rough machined to required dimensions. Welding kerfs are provided in the same machining operation.

Welding Conditions as a Design Criterion

Another typical criterion is the welding conditions imposed by the design. Full strength welds must be accessible so that they can be executed properly. Too,

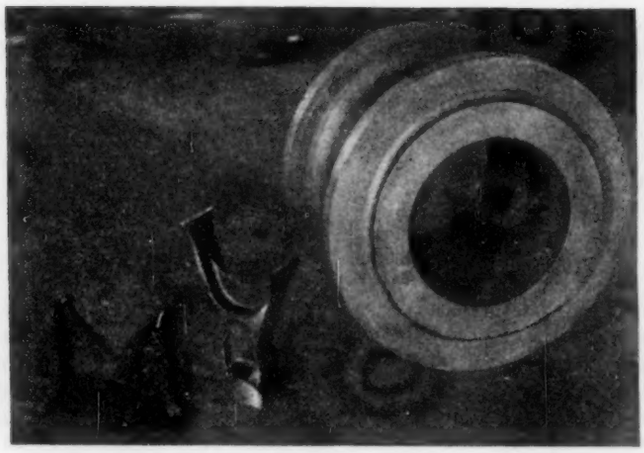


Fig. 29—Drop-Forged Components, Typical of Thousands Which Have Been Used in Weldments

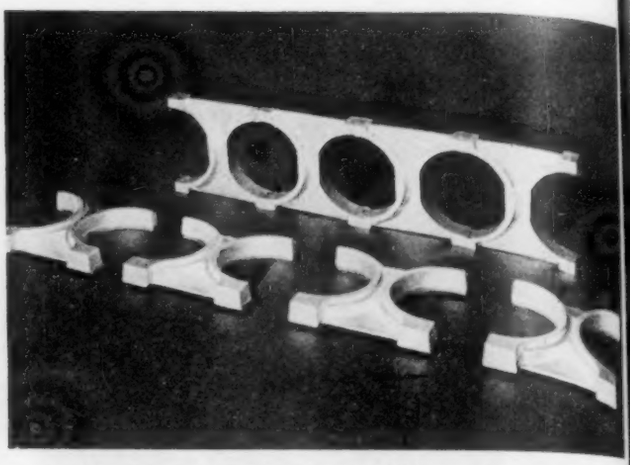


Fig. 30—Drop-Forged Sections Which Were Flash Welded as Shown to Form a Component of a Weldment

they must be designed so that they can be inspected readily. The first question here for the designer is the quality of weld required

We have in Fig. 22 a typical subassembly as an example, with the welding on this completed as shown, accessible from the standpoint of both welding and inspection. Shrinkage and warpage have been eliminated as effects on the final assembly. The other portion of the final structure also has been welded under most accessible conditions. It has been inspected and controlled separately from the standpoint of shrinkage or warpage.

Figure 23 shows the subassembly previously shown in its final position with the joining welds between this subassembly and the remainder of the structure executed through the openings.

Trends in Types of Components

Definite trends emerge in the type and form of components being used in weldments. These trends are established naturally by economy and inherent design freedom.

It is quite evident from the examples given that hot-rolled plate is the predominant component. Undoubtedly this is due mainly to the freedom in design that two-dimensional plates allow, for almost any conceivable size or shape can be designed using plate as the basic component.

Judicious use of other types of components in combination with plate provides added freedom and economy. The various methods of shaping or forming plate are utilized for the same reasons.

The most widely used plate component is, of course, the flame-cut shape.

Bent plates typified by those shown in Fig. 24 are used to advantage in many applications. The stiffening side members of this hydraulic press frame are of plate formed on the press brake. Their use in this typical instance reduces the welding required, provides initial stiffness or stability in the component, and adds to the appearance of the weldment.

The primary member of this frame is composed of two plates formed on the bending rolls and butt welded.

The utilization of plate components formed on the bending roll is exemplified also by this huge weldment, Fig. 25, which is part of a hydroelectric installation.

Hot flanged or "spun" heads often are used to advantage as components. In the weldment shown in Fig. 26, one head is halved to provide the vertical walls and rounded corners of the main portion of this structure. Welding is simplified and better appearance results. With the advent of quantity requirements there is a trend toward the use of hot pressings or stampings, as shown in Fig. 27. This one is approximately 53 x 10 x 6 in. of $^{7}/_{16}$ in. thickness. Two such pressings form the major portion of the housing pictured in Fig. 28.

Designs based on quantity production included to advantage drop-forged components. Those on the left in Fig. 29 are typical of the thousands which have been used in weldments. They provide freedom of shape and eminent predictability where necessary and forging die cost becomes insignificant in such quantity applications. The forged and machined component on the right forms the hub of the large gear blank in Fig. 8.

Figure 30 is an interesting specialized use of drop-

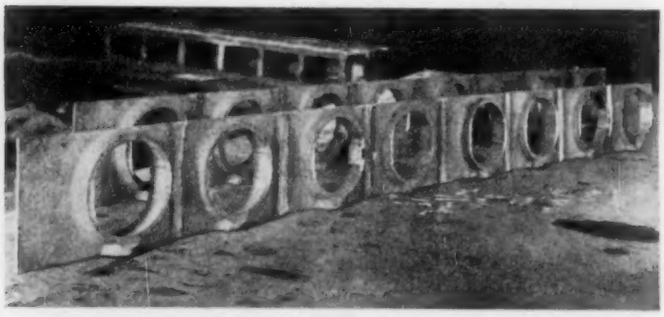


Fig. 31—Eight Small Steel Castings Are Flash Welded to Provide This Component

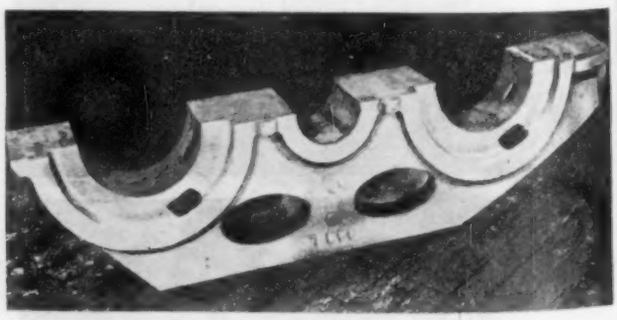


Fig. 32—Component of Machinery Weldment. Such Components Are Used in Weldments of Such Size or Nature to Be Prohibitive, or Impossible, as One-Piece Steel Castings or Forgings

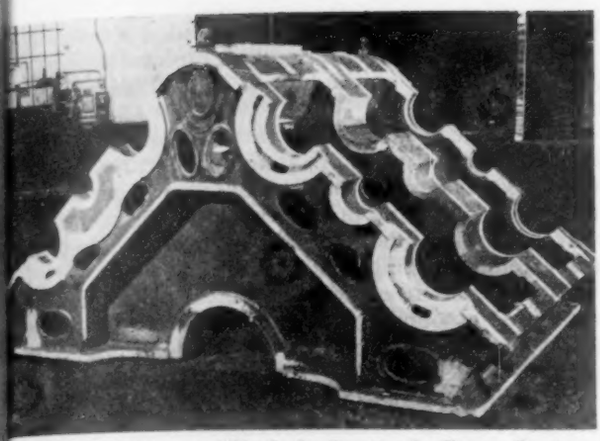


Fig. 33—Weldments in Which the Previously Shown Casting, Fig. 32, Is Used

forged components, composed of several small forgings which are flash welded together. Design freedom in shaping for minimum weight and maximum predictability results.

Castings are utilized in a similar manner in Fig. 31. Eight small, hence more predictable, steel castings are flash welded together to provide this component.

Hundreds of tons of steel castings as shown in Fig. 32 are used as components in machinery weldments and this use has opened a completely new market for steel castings as well as forgings. Generally, such components are used in parts of such size or nature to be prohibitive or impossible as one-piece steel casting or forgings.

Figure 32 pictures a typical cast steel component. Clearly, this portion of the weldment would be more costly in plate, but properly specified and controlled steel castings are eminently satisfactory.

Figure 33 is the weldment in which the previously shown casting is used. Six such castings or larger ones are used in this one piece.

There is a tendency to utilize standard structural rolled shapes in machinery weldments though their value as components is questionable in many instances. This is logical when it is remembered that available rolled shapes were evolved for an utterly foreign purpose. Hence, their use in machinery parts often seems a makeshift.

Figure 34 is a typical elementary comparison. The original design—utilizing I-beams and angles—is shown on the left with the redesign adopted on the right.

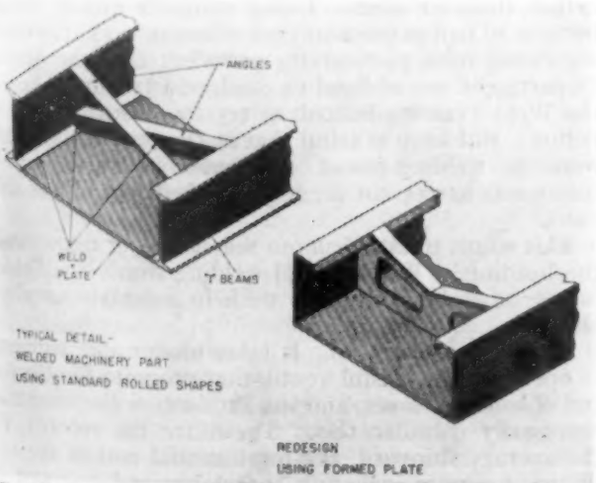


Fig. 34—Elementary Comparison Showing Original Design Utilizing I-Beams and Angles, on Left, and Simplified Redesign on Right

Welding is reduced, lateral stability is increased and the appearance is better. Also abrupt projections are eliminated, fitting and welding are simplified and the transverse member is more effective at equal weight.

It is possible that shape mills will evolve new sections as required tonnage develops and if so, the shapes will be designed to suit this new function.

We operate a small tonnage mill which provides rough shapes such as these shown in Fig. 35, solely for weldments. Roll cost is low but this is essential to the relatively small tonnages required. As a result surface finish is not equal to that of the usual shape in quality but the product is well suited to its use.

This mill has provided us with added design freedom and gives us such components, which formerly were machined from solid slabs.

Welding Specifications Need Developing

Finally, we have the important subject of specifications.

There is no well-defined trend as yet developing in the specification of welded machinery parts, at least, none that I can see, except that progress has occurred in nomenclature. Weldments procured by or for government agencies, for instance, are clearly specified, and

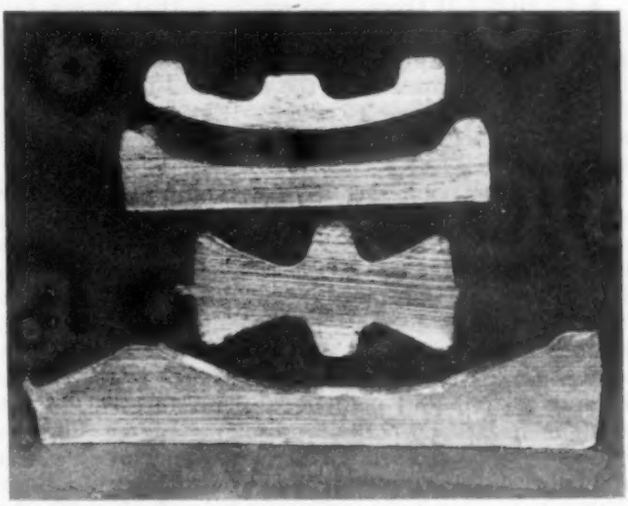


Fig. 35—Rough Shapes Such as These Are Rolled for Weldments. Added Design Freedom Results

type, extent and control of inspection are fairly well developed. On the other hand, specifications on commercial welded machinery parts are too often pretty general and lean, and this causes discouraging delays in pricing and final design.

It would seem that valuable and important work can be done here by a coordinating agency since there is splendid opportunity for the compilation and correlation of design criteria.

As mentioned, nomenclature is comparatively well developed and welding symbols are standardized. But there are somewhat complex items of specification on a welded machinery part in contrast to those on a casting.

What type of weld joint shall be used and where? (Much remains to be done in the evaluation of types of joints before the basis of this specification is available.)

What type of electrodes shall be used and where?

What method of inspection shall be used and where?

What are the standards for such inspection?

How and to what degree shall the weldment be tested?

Should it be stress relieved?

What tolerance can be expected and where?

Today the codes and standards of many agencies overlap in the specification of welded machinery parts. It is reasonable to assume that none is adequate for they were established for other purposes.

It is my conviction that the commercial designer literally has no guiding standards with the exception of nomenclature. It is inconceivable that he does not at times apply weldments in which faulty design endangers human life.

It has become common procedure for the user to rely on the supplier to develop his specifications for him, but there is nothing alarming in this if fundamental standards are available.

Specifications undoubtedly are guided often by equipment limitations, inventories, geographical location, individual experience or the lack of it, or ill-advised conventions.

All these can generate a rather chaotic, unstabilized condition in the industry, assuming that the production of welded machinery parts properly can be termed an industry. Costs and prices are widely divergent and will so remain until fundamental specification standards are devised and promulgated.

Much experience and basic information with service records as a sound foundation exist. Ultimately valuable work will be done in its compilation, correlation and in filling of the gaps.

It would seem reasonable to conclude that the whole subject is one of mechanical engineering. This is true since we are considering only mechanical parts.

Control of Welding Fumes—Why and How*

By Lt. Morwick Ross, USNR†

ALTHOUGH there is no evidence that fumes from black iron welding cause any permanent injury, industrial physicians agree that black iron welding fumes are irritating to the nose and throat and can produce a disagreeable cough. Since approximately 90% of shipyard welding is black iron, these disagreeable effects are cause for concern.

Most of the remaining 10% of welding is on galvanized or painted steel. Inhalation of zinc oxide fumes which are generated from welding on galvanized steel, may produce a 24-hr. illness called metal fume fever, characterized by chills and fever and an upset stomach. It is an old story to most pipe welders. Doctors state that the illness leaves no after effects, and repeated exposures appear to do no permanent harm to the welder. Welding on red lead painted steel produces lead oxide which is hazardous. Lead poisoning among shipyard welders is still practically unknown after three years of producing ships at high speed, but to ignore the possibility is to invite trouble. Shipyards in which red lead is used must never ignore the danger of lead poisoning.

This has been a very brief review of the effects of exposures to welding fumes in shipyards today. It scarcely begins to tell the whole story, but it serves as one good reason why welding fumes must be controlled.

I won't go into detail on this second reason—let me merely review some of the more popular ailments imagined to arise from welding fumes. Tuberculosis probably is the number one fear among welders. Industrial physicians state that there is no evidence that welding fumes can cause tuberculosis, but the fear is strong among many shipyard welders.

"Coated lungs" have become increasingly popular as the length of exposures to welding fumes during the war has increased. Just what "coated lungs" are or what they will lead to is not clear, but the picture of the inside of his lungs is very clear to many a welder. Some even know the depth of the coating. I have had more than one welder volunteer the information to me that he had three-sixteenths of an inch coating of welding fumes on the inside of his lungs. Certainly it is not a very reassuring picture to any welder who imagines himself to be so afflicted.

The fear of ulcers resulting from welding fumes is also strong. Doctors state that there is no connection between ulcers and welding fumes. Yet the idea persists.

That there is no limit to the human imagination is illustrated by this last example—employees of one large West Coast Shipyard decided that they could not wear hard hats, the trade mark of every modern shipbuilder. It seems that there is a small space between the headband and the shell of the hard hat. The employees of this shipyard determined that welding fumes could drift in through this space, become trapped inside the hat, and cause their hair to fall out.

It is certain that the imaginary illnesses from welding fumes are worse than the real ones in terms of employee morale, for a man who is afraid of his job is a liability rather than an asset. Labor turnover among welders became so bad in one shipyard where rumors about welding fumes were particularly prevalent that the Medical Department was obliged to conduct a training course in the Weld Training School, to try to substitute facts for fiction. But keep in mind that at the root of the trouble were the welding fumes. Adequate control of welding fumes was as yet not an accomplished fact in this shipyard.

This seems to establish our second major reason under the heading—"Why control welding fumes?" Welding fumes must be controlled to help maintain employee morale.

Here is a third reason. It takes money and manpower to operate a successful ventilation program for the control of welding fumes, and the Production Engineer must necessarily consider this. These are the records: For the average shipyard, the total annual cost of the ventilating program including both labor and cost and depreciation of equipment is 1.5% or less of the total annual payroll of the Welding Department.

The opinions or assertions contained in this article are the private ones of the writer and do not necessarily reflect the official views of the Navy Department or the Naval Service at large.

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The question is then, can the successful control of welding fumes on the hulls, in the sub-assembly sections, and in the shops increase the daily welding footage by 1.5%? Put it another way. If a welder burns 17 lb. of rod a day under poor conditions (which is a reasonable average for production welding), can he and will he burn ¼ lb. of rod additional when the compartment in which he is working is well ventilated? Yes, in fact he will burn considerably more. Superintendents have estimated that daily welding output in confined areas on the hulls increased by 3 to 5 lb. of rod per man, after a good ventilation system was installed.

First Hand Knowledge

Having spent what seems to me to be most of the war in ships tanks and innerbottoms, I speak from first hand knowledge when I say it is literally impossible for a welder to put in a full day's work in the oppressive atmosphere resulting from poor ventilation. It is no surprise to those of you in shipbuilding when I say that an appreciable part of the working day of a welder detailed to work in such a compartment is spent out on deck getting what he calls a "blow." Nor is that any surprise to the welding foreman and superintendent who are often obliged to plan their work sheet on the basis of how many welders they can group in a given space on the hull without making the space unlivable.

It has no doubt already occurred to you that welders on the skids do not benefit from ventilation and therefore should not be included in this consideration. True, but welders do not alone benefit from control of welding fumes. Every other craft on the hulls benefits as much and the unit output of these other crafts may reasonably be expected to increase. From the viewpoint of costs of control of welding fumes, therefore, there can be no reasonable doubt that welding fume control not only pays for itself; it represents profit through increased production.

Generally speaking, the answer to the "how" in controlling welding fumes is, of course, by ventilation. But ventilation for the successful control of welding fumes during ship construction cannot be a hit or miss affair. It must be carefully planned and executed. There is no such thing as partial control of welding fumes. You either do the job or you don't do the job.

The ventilation program I am about to describe is not an utopian dream. It is a faithful description of the ventilation program in effect today in at least four large shipyards building cargo ships and troop transports. They are all on a fast building schedule of from two and one-half to five months from keel laying to delivery. The ventilation program which these yards have in operation can be tailored to fit any shipyard, and since every shipyard has at least a part of this program already in operation, it would not be hard to incorporate all of it.

There are three essentials to be observed in organizing a successful ventilation program: first, ventilation equipment of proper design and in sufficient quantity; second, a well trained ventilation crew of sufficient size; third, a carefully designed ventilation system.

First, equipment. I appreciate that most of you already have most of your ventilation equipment, but you may be ordering additional equipment, and you will be ordering replacements.

Almost any type of ship can be ventilated with four types of blowers. The first type of blower is the workhorse of the ventilation system. It is a high capacity, medium pressure blower, delivery about 15,000 c.f.m. The cost is about $300. It is used to ventilate cargo holds, large tanks, engine room and deck sections.

The second type is a smaller edition of the first. It is a medium capacity, high-pressure blower delivering 5000 to 6000 c.f.m. at 10 in. pressure. It is used for ventilation of small tanks, double bottoms, and with relatively long runs of duct work in inaccessible compartments. It is a dual purpose blower, for by attaching an adapter to the inlet side it is used for local exhaust ventilation with four 3-in. diameter flexible tubes. The blower costs about $250.

The third is a propeller fan delivering from 4000 to 8000 c.f.m. of free air. This type of fan develops low static pressure and is not intended to be used with ductwork. It is intended purely as a booster, to create or maintain air movement along passageways, trunks and the like. It is light in weight and is therefore more flexible on the hulls than the other types. Its cost is from $175 to $200.

The fourth type is intended to be used as an odd-job fan. It should be light in weight, and from 1500 to 2500 c.f.m. capacity. It is used for ventilation of pickup welding, for ventilation of very small spaces as cofferdams, in fact, wherever the standard ventilation system cannot be used.

These four blowers form the backbone of a temporary ventilation system. Other types are used successfully in place of these, and I have no intention of disqualifying them. However, these four represent basic fan types which in combination will produce the desired results.

Advocates Duct

Under the heading of equipment comes duct and fittings. The tendency in many shipyards is to shy away from the use of duct. Don't be afraid of it. Failure to use ductwork unnecessarily penalizes the ventilation system by reducing the effectiveness of blower equipment.

Rigid sheet metal duct has proved to be most successful. It withstands the abuse it inevitably receives, causes the lowest friction loss and therefore delivers the most air. It may be installed quickly and easily with well-designed fittings. Its single major disadvantage which is outweighed by the many advantages is the area required to store it.

The duct may be made of 18-gage sheet metal. All duct sections should be standardized as to length and diameter. In a similar manner, all fittings such as tees, elbows, reducers, etc., should be standardized. The object of this uniformity of design is of course to make the parts of the ventilation system interchangeable throughout, thus keeping the inventory of duct and fittings at a minimum.

Speed in handling is the primary consideration in designing the details of the duct and fittings. Duct section couplings can be designed which can be attached in a matter of seconds without tools, and are to be preferred to a nut and bolt coupling. But don't let the system become so highly refined it becomes unwieldy. Ventilation of ships under construction is a rough job where quality can largely be sacrificed to simplicity and speed in execution.

Perhaps most important to the scheme of things, but often most neglected is the ventilation crew. With the critical shortage of manpower which has constantly harassed the shipbuilder, those departments not directly engaged in construction have been almost continually undermanned. This has been consistently true of the ventilation crew. However, the importance to the shipyard of the ventilation crew must be kept in mind, and if it is undermanned, it should be given a high priority for additional men.

The ventilation crew should be part of an operating, not an administrative department. In most shipyards

the Electrical Maintenance Department is responsible for ventilation, an arrangement which has proved satisfactory.

The ventilation crew must have ventilation duties only to perform. Combining ventilation with temporary lights, for example, is a common fault. Temporary ventilation is a full-time job when it is done well—a job requiring skill and constant attention.

The size of the crew is difficult to predict since it depends on so many variables, but for purpose of rough estimation, two men per way and two men per hull at outfitting, not including supervision, would probably be a minimum in a shipyard building Liberty or Victory Ships.

The members of the ventilation crew must be thoroughly familiar with the ventilation procedure adopted as the standard design for all hulls. Their duties embrace installing the ventilation equipment on the hulls and operating the equipment to its maximum efficiency. During time not required for actual setting up of equipment, they are expected to perform the function of ventilation inspector, periodically covering the hull, looking for inoperative equipment and for inadequately ventilated spaces.

The final factor in the "How" to control welding fumes is the design of the ventilation procedure. Experience has shown that there are a few general rules to observe. First, keep it simple; second, make it semi-permanent; third, standardize designs for all hulls at all stages of construction.

The design of a standard ventilation procedure is an individual job for every shipyard, since the design will depend upon the type of ship, the construction sequence and the amount and type of ventilation equipment on hand. Any shipyard can arrive at a successful design in the following manner however:

Successful Designing

First, from a physical inventory of ventilation equipment on hand, classify all blowers into groups according to their performance characteristics. Blowers of approximately the same air capacity and pressure may be grouped together regardless of their make or exact dimensions. Later, in designing the ventilation system, with the duct sections and fittings also standardized, ventilation for an entire area may be described very simply as, for example, a group 2 blower with four type A duct sections, one type J elbow, and one type G outlet.

In laying out the system itself, the hulls should be considered as broken down into large sections, and ventilation laid out for a section at a time. The major bulkheads may be taken as section lines, so that in a Liberty Ship, for example, ventilation will be designed for the forepeak section forward of the crash bulkhead, holds 1 through 3, engine room, holds 4 and 5, and afterpeak. In every case the section includes everything from double bottom to the first deck. Superstructure may be regarded as another section requiring individual attention.

As far as weather conditions permit general ventilation should be used for all black iron welding. Local exhaust ventilation requires the participation of the welder, and since that participation usually is not forthcoming, local exhaust is not effective.

The volume of air to move through a given compartment must be determined by local conditions. An air change per minute may be taken as a reasonable ventilation rate for any closed tank as double bottoms, deep tanks, void spaces and the like. During hot weather this ventilation rate may be increased.

The ventilation system of a given space should be installed as soon as the construction sequence of the ship calls for it, and must remain in place until work is completed in that space. Ventilation may be launched with the ship to permit ventilation during outfitting.

Use may be made of temporary access holes cut through bulkheads or decks for ventilation of otherwise inaccessible compartments. The Navy, Maritime Commission and American Bureau of Shipping have made a practice of permitting this where structural strength permits.

Finally, when designs have been adopted for the entire hull, blueprint them so the ventilation crew will operate uniformly on all hulls. Deviation from the standard ventilation procedure should not be permitted unless it has been cleared through the Ventilation Supervisor and has been formally incorporated in the blueprints. Some shipyards have conducted a brief training course for the ventilation men to familiarize them with the ventilation procedures, and have furnished each man with a pocket size field notebook containing complete blueprints of the system.

May I remind you that shipyards have found it to their distinct advantage to maintain good ventilation of ships under construction, are daily saving manpower and increasing production through adequate control of welding fumes?

Multiple and Stack Machine Cutting*

By A. H. Yoch†

Historic Background

ONE of the first applications of oxygen in the metal-working industries was the use of the Oxygen Lance described by Thomas Fletcher in 1888. Several years later, it became an accepted practice to employ the lance for tapping "frozen" tap holes in blast furnaces. Although the lance required no fuel gas for continued operation after the combustion of the steel had been started, it must be considered the forerunner of the cutting torches using oxygen and hydrogen, and later oxygen and acetylene.

The original cutting torches consisted of a welding torch with a supplementary oxygen tube clamped on the side, and so placed that the oxygen cutting jet impinged on the spot preheated to a redness by a reducing welding flame. This tube was connected by a third hose to its own pressure regulator and cylinder of oxygen. This type of torch was generally used for several years after the Jottrand United States Cutting Torch was patented in 1905. Later, this patent was declared invalid; thereafter, the two hose torch with cutting tip—preheat flames surrounding the cutting jet—came into popular use.

In several years, intensification and expansion of the nation's industries created a demand for improved cutting; this led to the development of a flame-cutting machine. The early machines consisted of a hand-driven screw and guide mechanism providing three-dimensional movement, but limited to straight-line cutting.

Under the impact of World War I, the pressure for greatly accelerated industrial production brought forth the Radiagraph, a light, portable, motor-driven machine for circular and straight-line cutting. Since that time, several models and types have been developed, with thousands now in use throughout American industry.

During this same period, the Oxygraph was developed. This was the fulfillment of the industriald emand for an irregular-contour and shape-cutting machine, since this more complex type of cutting could not be readily performed by straight-line cutting. This machine was an application of the principle of the pentograph, using parallel, jointed and connected arms. The Oxygraph, by employing a motor-driven, manually guided, tracing device, made possible the tracing and cutting of figures of any shape with uniform, steady movement. This was a notable contribution toward the processes of fabrication and assembly.

The motor-driven, straight-line and circle-cutting machine, the Radiagraph, and the motor-driven tracer and pantograph machine, the Oxygraph, though crude by present-day standards, served industry efficiently and well. As a direct result of these initial contributions, outstanding developments have taken place in the field of machine flame cutting, so that at the present time, precision processes have become an integral part of American industry.

By the time the United States formally entered World War I, the demands for armament and ships had increased to such proportions that industry, working at full-capacity, found itself incapable of meeting this avalanche of orders and assignments. This was the condition that forced industry to find new ways and means of stepping up production without proportional increases in plant facilities and man power. One of the principal factors in the solution of the problem was the development of mass-production techniques. In the field of machine flame cutting, this was accomplished by the mounting of several torches on the torch arm of the cutting machines—multiple cutting; and through the utilization of techniques for the simultaneous cutting of multiple layers of metal plates—stack cutting.

Typical of the problems of the period was that confronting one of the largest fabricating mills in the midwest, in the cutting of $^1/_2$ in. x 8 ft. x 30-ft. steel plates. This cut, twelve ft. in length and composed of sixteen different radii, adjoined other pieces in the assembled product. In hand cutting the plates, it was found that production was slowed through the necessity of chipping and grinding the cut. To overcome this difficulty, the engineers turned their attention to machine cutting by the use of a Radiagraph.

The use of the machine presented a special problem since it was totally impractical to curve the track to conform to the small variable radii of the cut. This was overcome by the use of a special torch mount, built to swing freely on the post of the machine. One end of a tension spring was attached to the torch, the other to the post, thus the torch was held in constant contact with the template. The template was made to the same profile as the desired cut. This arrangement permitted the Radiagraph to travel on a straight track as the cut progressed, yet provided for the necessary lateral movement of the torch.

The cutting time for a single plate was 22 in. per minute; this proved too slow as the deadline for delivery had drawn very near. To speed production, a stack of four plates was cut, then eight. These proved so successful it was decided to stack cut twelve plates. To insure the best possible cut, bolts were placed at 3-ft. intervals to clamp the plates tightly together. The most effective and economical cutting speed was found to be 12 in. per minute; thus the stack cutting stepped up the equivalent linear cutting speed from 22 in. to 144 in. per minute. The cuts were found to be sufficiently smooth, square and clean to permit direct assembly of the plates with no further finishing.

This was typical of the experience of many mills throughout the country during World War I. Flame cutting equipment, while not strictly new, had been in use for so short a period that, generally speaking, industry had not discovered the vast ranges of possible per-

* Presented at the Annual meeting of the AMERICAN WELDING SOCIETY, Cleveland, Oct. 16–19, 1944.

† Machine Cutting Specialist, Applied Engineering Dept., Air Reduction Sales Co.

formance and application. By the time of the Armistice in 1918, machine stack and multiple cutting had become firmly established throughout American industry. Through the war period and the following decade, many new developments and refinements were added in the field of machine flame cutting. However, as far as we can ascertain, there is no evidence of a machine mounting more than two torches until 1929.

In 1930 the first four-torch, centrally operated machine was constructed; this included central control of the preheat flames and cutting jet in addition to providing an automatic torch lighting mechanism. These were innovations in the field but the purchaser, one of the nation's largest and most progressive manufacturers, had sufficient confidence in flame cutting to set aside $5000 to cover the cost of development of a machine incorporating these features.

The machine when completed shown in Fig. 1, contained several important and original characteristics. Among these were:

1. Special work-table
2. Special tracing device
3. Hose supports
4. Gas manifold system
5. Automatic torch-lighter

A special non-floating tracing device had to be developed because the weight of the four torches was so great that the standard tracer could not be used. The manifold system, mounted directly onto the back of the Oxygraph, was developed for efficient distribution of acetylene and high and low pressure oxygen. The manifold, equipped with blow-off valve and flash-back arrester, was fed through regulators from cylinders. From the manifold, the gas flowed through valves and thence through individual regulators to control valves consisting of gas savers for preheating gas and a special attachment-assembly for the cutting jet. These valves were controlled by jackshafts connected by positive, adjustable links to solenoid-operated levers, which, in turn, were controlled by electric switches at the operator's position near the tracing device. The solenoid mechanism is shown in Fig. 2.

The automatic torch lighting mechanism consisted of city gas pilot lights controlled by a $^1/_4$-in. solenoid valve with by-pass adjustable for desired size of pilot flame. The torch was also fitted with 3-dimensional indicator for angles between 0° and 45°.

With the universal acceptance of machine cutting, it might appear that the potentials of this phase of production would be inexhaustible by merely employing machines equipped with a greater number of torches and larger work tables. While it was true that this principle was applicable for work requiring no great accuracy, it was equally true that there were undetermined factors that produced irregularities, rendering large scale precision cutting, the type demanded by a large part of industry—impossible.

A program of concerted effort and study was launched in order to reduce these adverse features. It soon became obvious that success lay in an empirical solution as the elements producing the deviations were myriad.

The principal factor involved was found to be "plate-motion." A picture of this motion and its net effect can be gained by considering the common portable type of machine. Where the track of the machine rests directly upon the plate, any movement of the plate will shift the track in a manner which is dependent upon the relation of points of track support and the zone in which the motion occurs.

In operations where the machine is supported independently of the plate, the track will not be affected by any change of location of the plate, and the path traveled by the cutting tip will be defined entirely by the track location and the action of the machine. The location of the cut on the plate then becomes a matter of relative location of the tip and plate at the point of cutting. The plate may move slightly, but the tip will not move correspondingly, thus creating an irregularity in the cut edge. With the various shape cutting machines mounted independently of the work, we have this problem of relative location and its bearing upon accuracy.

Although plate motion has been recognized for a long time, only by making observations has the degree and

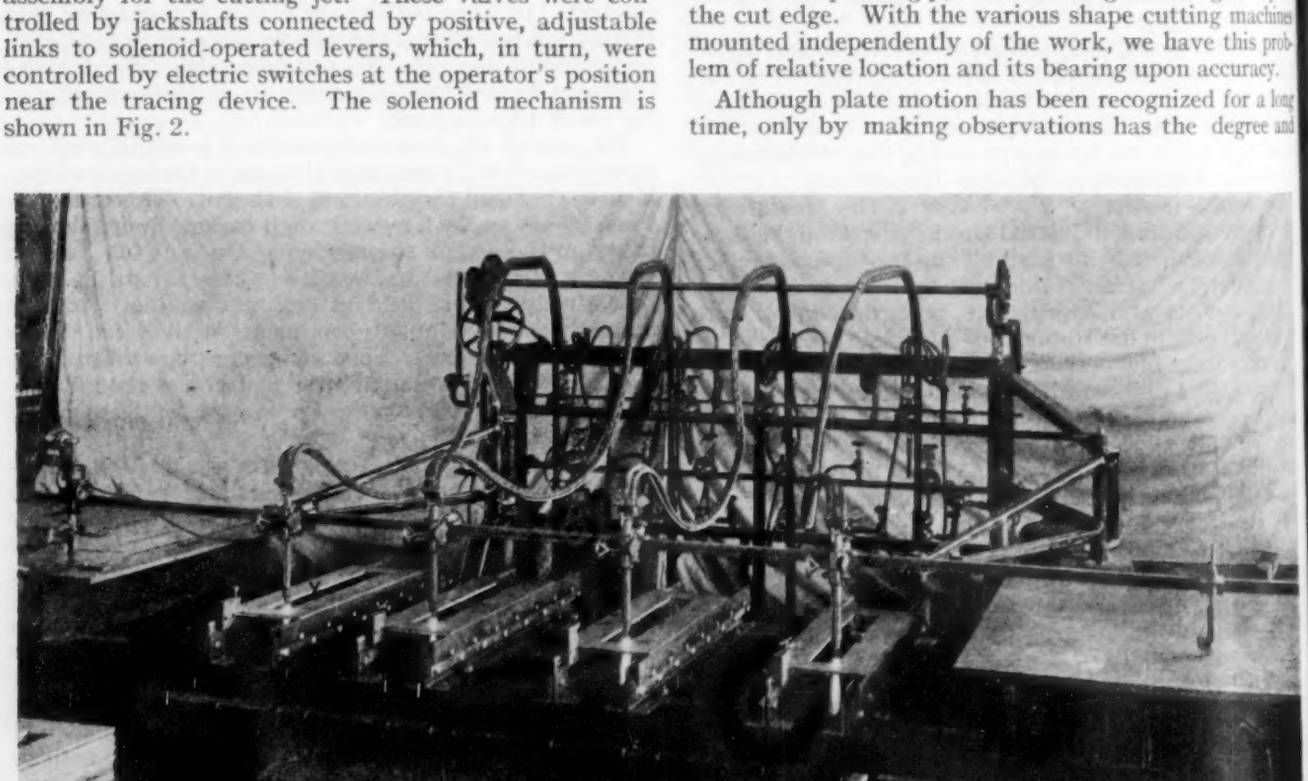


Fig. 1—This Forerunner of the Present-Day Oxygraph Was the First Gas Cutting Machine to Carry More Than Two Torches. It Incorporated Numerous Innovations

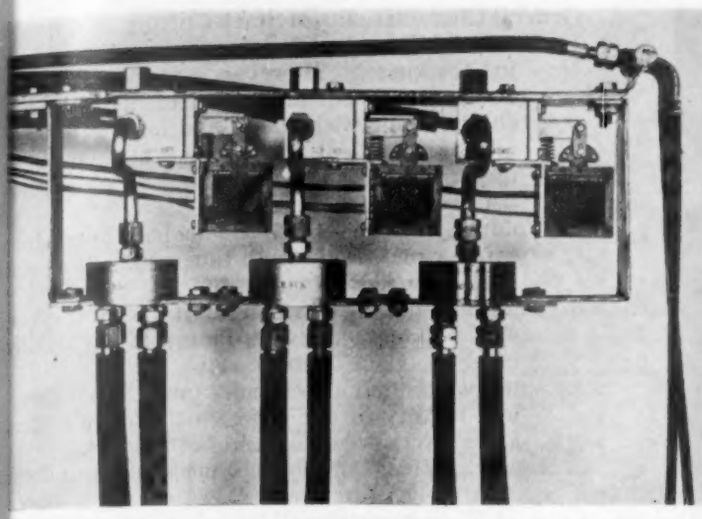


Fig. 2—Early Solenoid Valve Mechanism on Machine Shown in Fig. 1. This Provided Central Control of the Multiple Torches, and Operated in Conjunction with Pilot Flame Torch-Lighters, Another Innovation

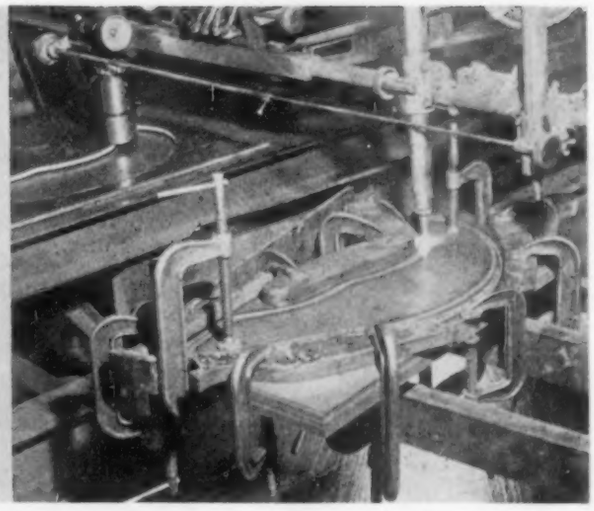


Fig. 3—A Common and Effective Method of Clamping Thin Plates for Stack Cutting Is the Use of C Clamps. Here They Are Used with Heavy Flat Bars to Distribute the Pressure

manner of motion been determined. In forming some shapes, the movement of a portion of the plate is very evident whereas with other shapes, it may be so slight that it is not readily apparent, and an assumption might be made that no motion exists. Where accuracy is required, any definite information concerning this motion with respect to the point of cutting will provide a basis for predicting the degree of accuracy expected.

The significance of plate motion lies in the fact that this, coupled with other factors can seriously affect the final results. Where motion exists ahead of the torch, the actual dimensions of the finished part will be affected. Assuming that plate motion is the only factor which affects the line of cut, experimental data* can be used to predict the general finished shape and the general expected location of errors. In the case of exterior cuts, any movement of the plate inwardly from the line of cut and just ahead of torch will result in a plus dimension, and conversely any plate motion outwardly will produce a minus dimension.

The analysis of the plate motion brings out the fact that the cut may be affected by either of two resultant conditions. The first is the independent "snaking" of the plate. The second is the body movement of the plate when one side rests against a rigid point, thereby providing a fulcrum point. If the plate tends to move and is stopped by some projection or excessive friction, a rotational effect may result.

After assimilation of the data obtained from the extensive research on the behavior of material under varied conditions of cutting, it was possible to derive certain factorial corrections against the deviations produced under standard cutting practices. It was apparent that if the plate were mounted in a manner which permits freedom of motion, the tendency toward error would be minimized. If the plate could be firmly secured at a single point in the center—a neutral point—any local disturbances would affect only slightly, if at all, other portions of the plate. However, central support is usually impractical since in most cases at least three points of support must be provided, the exact number depending largely upon the specific shape being cut. With these three points located inside of the line of cutting, and with these supports made smooth and round to introduce a minimum of resistance to motion, the plate can still shift locally, yet any rotative tendency will be eliminated. The general problem of mounting the plate proves to be a very important factor if accuracy is to be obtained. The supports should be more than just a load carrying arrangement, they should provide for control of the inherent motion so that the cutting is not affected. Any arrangements of support not permitting this control introduce inaccuracies.

Aside from the quality of straightness, there existed other conditions such as angularity, location of openings, or angular error of bevels. It was impossible to obtain an exact angle between a side and an end made in continuous cutting, if during the course of the cut, a slight rotation of the plate developed. Likewise, an opening would be incorrectly located if the plate had moved prior to making the cut unless adjustments in the plate or template location were made.

The specific problems encountered in precision cutting require a knowledge of conditions that are likely to exist. With the results obtained from the experiments at hand, procedures can be determined that will assist in establishing the required control and minimize the chance of inaccuracies. While this discussion centered mainly on the conditions existing within the material during cutting, the work disclosed the presence of other important factors; among these were:

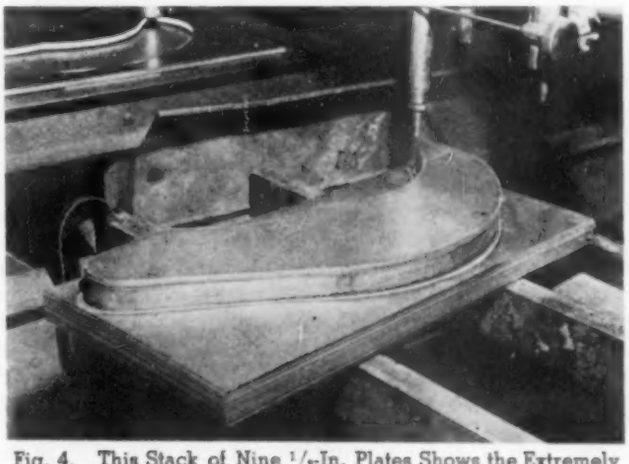


Fig. 4. This Stack of Nine 1/8-In. Plates Shows the Extremely High Quality of Cut Obtainable by Careful Stock Cutting

* "Factors Affecting the Accuracy of Machine Gas Cutting," H. G. Hughey and A. H. Yoch, THE WELDING JOURNAL, October 1942.

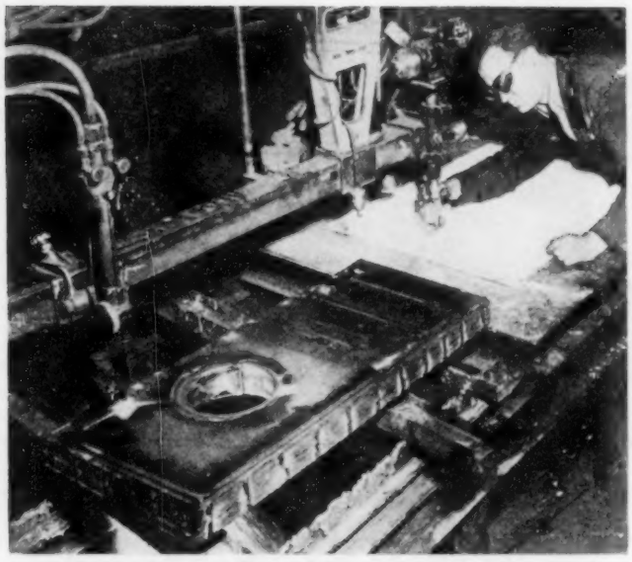


Fig. 5—Another Method of Holding Stacked Plates Tightly Together Is to Run Bead Welds Across the Plate Edges at Intervals, as Shown Here

(*a*) Shape of piece
(*b*) The cutting machine
(*c*) Accuracy of template and tracing device
(*d*) Cleanliness of machine
(*e*) Condition of machine (level, square, etc.)
(*f*) Ability of operator
(*g*) Characteristics of material
1. Chemical analysis
2. Surface condition
3. Heat treatment. Preheat before cutting, also postheating after cutting.

While numerous factors exist that can affect the accuracy of flame cutting, of those which can be controlled the most important is the maintenance of proper relationship between plate, torch, and guiding device. An understanding of the basic principles of the process, a knowledge and appreciation of good workmanship, a recognition of what is required and an analysis of what transpires during cutting are all necessary to obtain the best results. By application of the knowledge gained from the research project, there appears to be little reason for not obtaining accuracy equal to that of any other metal working process.

Stack Cutting

During the decade following the Armistice, there was little need to study the relative merits of multiple cutting and stack cutting since the cutting machines seldom mounted more than two torches. If the work involved the cutting of many pieces of identical pattern, using a material that lent itself to stacking in several thicknesses, and with an experienced operator available, stack cutting was normally used. However, if the job involved but few pieces of a single profile, using a material whose thickness or chemical composition did not lend itself to the cutting of several thicknesses, economics indicated the use of multiple cutting. However, with the development of the multi-torch machine, some of the work formerly done by stack cutting was given over to the multiple torches. Weighing of the relative merits and limitations of stack cutting against those of multiple cutting may explain the fields of work for which each is best suited at present.

A. General Characteristics of Stack Cutting
1. Generally limited to sheets and plates up to 1/2 in. in thickness. However, on gage-thickness sheets, stack cutting is preferable to single-sheet cutting with one or multiple torches, and offers an excellent alternative to stamping where quantities are not large enough to warrant expense of making dies.
2. Volume of work should be adequate to compensate for increased set-up time and possible cost of clamps, jigs or fasteners.
3. Material must be clean and flat, since if it is not, or if not cut carefully, failure of cut usually causes spoilage of entire stack.
4. Rate of production is usually quite high. Excellent quality of cut edges, with square corners and perfectly flat top and bottom faces.
5. Lower gas consumption per piece cut than if cut separately.

B. General Characteristics of Multiple Cutting
1. Any thickness of material, within the limits of cutting equipment capacity, can be cut. Scrap pieces can be utilized for cutting small quantities of parts.
2. Economy of operation does not vary appreciably with the volume of identical parts to be cut, and is not confined to large volume of work. No special work-fixtures are needed.
3. Plate stock can be run-of-mill material.
4. Rate of production depends on number of torches in use, and is usually less than in stack cutting because it is usually applied on heavier material.

The success of stack cutting is dependent first upon thoroughness of advance preparations of the plates and, second, upon the proper technique of operation. The first prerequisite is composed of the three factors (1) proper cleaning, (2) proper stacking, and (3) proper clamping. The preeminance of these steps can be fully appreciated if the principle upon which stack cutting is based is known. Several plates, so fitted and clamped as to assimilate the formal characteristics of a homogeneous plate, can be cut as though they were a single member of equivalent proportions. If adequate care is taken in preparation and operation, the cut edges of the individual plates are left smooth, square and even, making further machining unnecessary, particularly if the edges of the plates are to be welded. The best results are obtained if the stack is 3 to 4 in. in thickness, although this may be exceeded. An accuracy of 1/32 in. is possible for stacks under 2 in., of 1/16 in. if under 4 in. If accuracy is no great factor, a larger stack should be used for purposes of economy; on the other hand, the greater number of plates always involve a slight loss of accuracy through

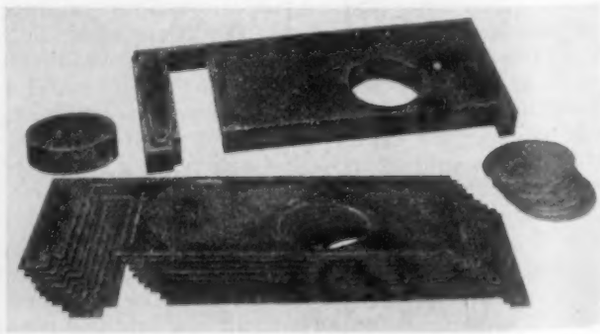


Fig. 6—Stack-Cut Parts Before and After Separation. Sharp Corners at Edge of Cut Are Characteristic of This Method of Cutting

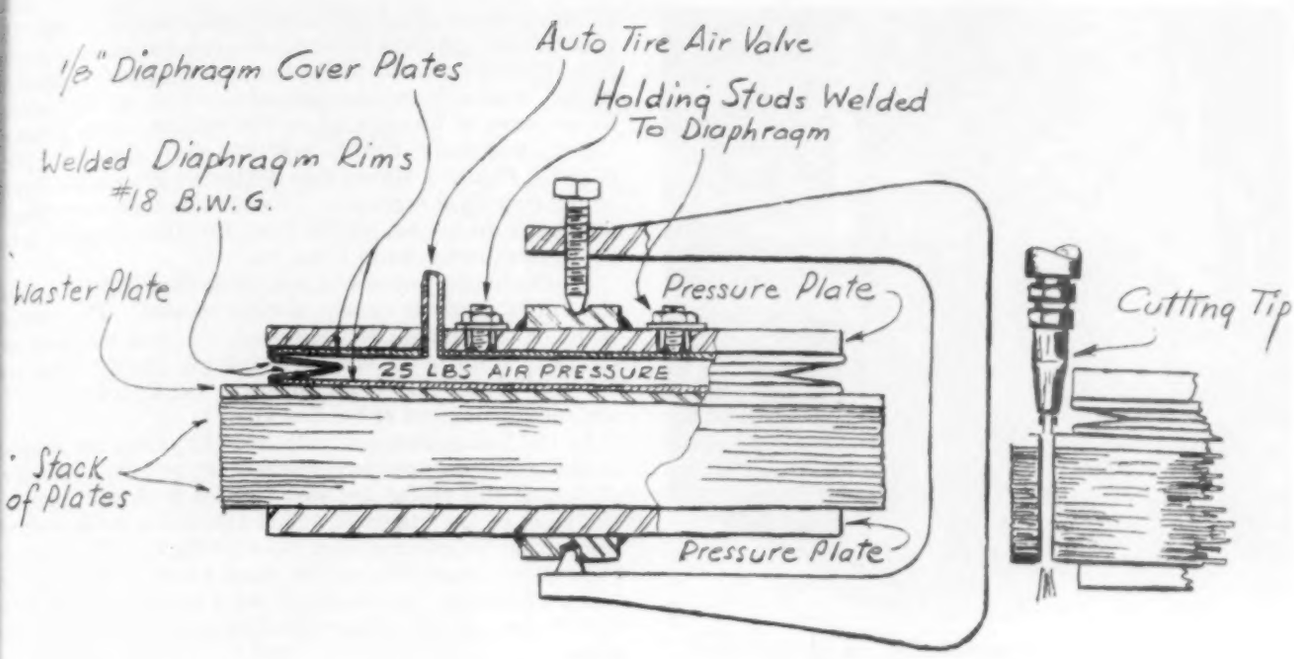


Fig. 7—Pneumatic Method of Clamping Plates for Stack Cutting. Pressure Diaphragm at Top Holds Plates in Intimate Contact Over Entire Line of Cut

varying width of kerf and difficulty of maintaining cuts at greater depths. In addition, in cutting very thin sections, the amount of heat required is sufficiently great to destroy the top plate; this negative factor is minimized by the use of a "waster plate," a plate placed on top of the stack to undergo this heat-damage.

To facilitate secure clamping, the plates must always be kept as clean as possible. Consequently it is essential that they be stored indoors in a clean, dry place, if possible in a flat stacked position to prevent bending or crimping. A physical or chemical cleaning process is applied to the plates immediately prior to cutting; this is usually accomplished by blowing with a jet of compressed air, by rubbing with wire brush or broom or, in extreme cases, by sandblasting or pickling.

Proper stacking refers to the observance of the correct arrangements of the individual plates composing the stack. Care should always be taken to expel all the air between the plates resulting from slight warping, bending or variations in thickness of the plates. This is best accomplished by hammering the plates along the line of cut.

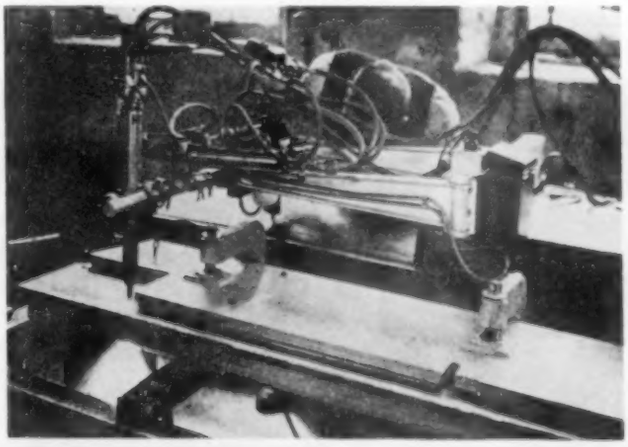
Proper clamping is most important, as upon this depends the figurative transformation of the pile of separate plates into a single, homogeneous plate. There are several methods of clamping in general use, the selection usually being dictated by the available facilities, nature and shape of cut and the type of plate.

The various types of clamping devices are familiar to all machine shop personnel—C clamps, wedge-type U clamps, toggle clamps, and pneumatic, hydraulic or magnetic clamps. In addition to these mechanical fixtures, bolts and bead or tack welds are frequently used.

Figure 3 illustrates the use of C clamps. As shown, the clamps are supplemented by metal bars fitted between the clamps and the stack to provide a more uniform distribution of pressure on the plates. In this case, the operation consists of the cutting of laundry press parts from a stack of nine $^1/_8$-in. plates. Figure 4 shows the extremely clean, square edges of the finished cut.

Figure 5 illustrates the use of tack weld at an average spacing of 3 or 5 in. to hold the plates during cutting. The stack consists of nine $^1/_4$-in. plates, 35 in. long and 16 in. wide. The center hole, included in the cut, is $7^3/_{16}$ in. in diameter. The cutting is done with a drawing tem-

Fig. 8—The Pneumatic Clamp In Use. This Type of Clamp Is Practical Only When Large Quantities of Identical Parts Are to Be Cut



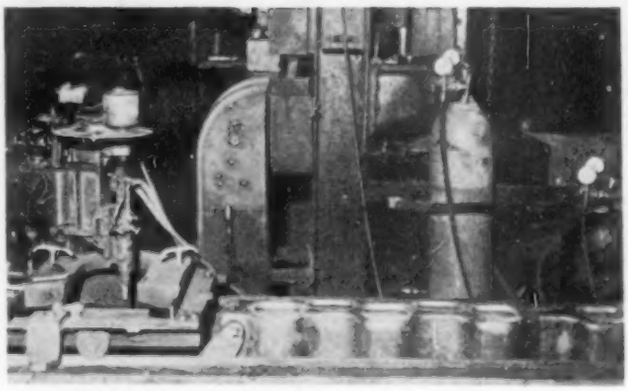


Fig. 9—Original Single-Torch Set-Up for Cutting Rectangular Holes in Tubular Headers. The Camograph Was Mounted on a Lathe Bed from One Cutting Position to Another

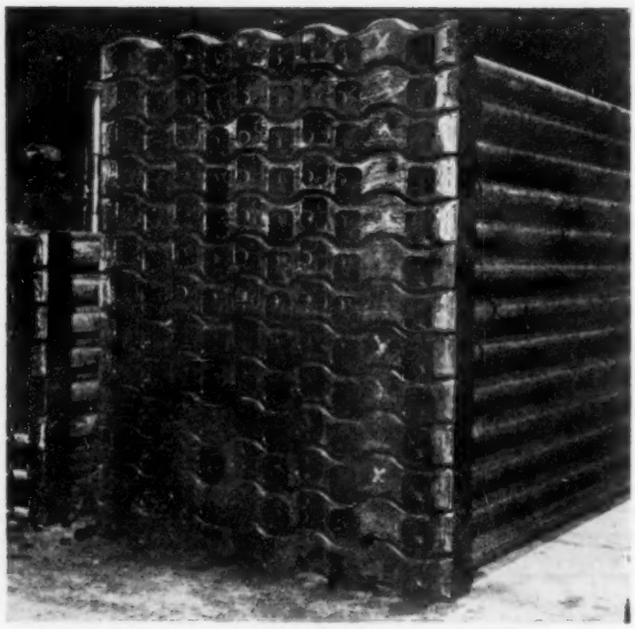


Fig. 10—This Finished Header Assembly Indicates the Magnitude of the Job of Cutting Rectangular Holes, One at a Time. Increased Production for War Necessitated the Set-Up as Shown in Fig. 11

plate, manual tracer, and a No. 4 tip. Figure 6 shows the completed parts before and after separation of the stack, and shows the well-formed edges of the cuts.

Figure 7 shows a diagrammatic layout of a pneumatic method of clamping. The stack is placed between heavy pressure plates. In the operation shown, a waster-plate is used because of the extreme thinness of the stacked plates; however, it is not an integral part of the system of clamping. Between the waster plate and the top pressure plate is a bellows-like diaphragm, composed of $^1/_8$-in. thick upper and lower cover plates welded to two 18-gage diaphragm rims to form a flexible air pressure chamber. This is fastened to the heavy top plate by means of studs. Through an auto tire valve, 25 psi. air or hydraulic pressure is introduced to the bellows, thus pressing the stacked plates tightly together along the entire path of cut. Figure 8 shows this device as it appears during actual cutting operations. The use of bolts in clamping is restricted to plates whose final function requires bolt-holes, rivet-holes, hand-holes, etc.

Stack cutting presents a hazard in that if the cut fails, the entire stack is nearly always spoiled. The critical point of the cut is the beginning. Several methods are used to minimize the chance of failure; chiefly, these are the use of (1) staggered pile, (2) preheated edge, (3) and/or starting cut of bead weld.

In the "staggered pile" method the plates are stacked so that each plate projects slightly beyond the one below. Although the plates are well aligned with one another, the edge of the stack at which the cut is to be started slopes slightly inward from top to bottom. This permits the cut to progress down the stack plate-by-plate as the torch advances. By the time the torch has reached the line of cut, all the plates have been penetrated by the flame.

In the "preheated edge" method the plates are aligned vertically at the start of cut rather than staggered. At the point where the cut is to begin, the plates are heated by the application of a welding torch, the flame of which is played up and down along the line of initial cut until all the plates have been brought to the kindling temperature. Upon reaching this temperature, the cutting torch of the machine is brought into position, and the cut is begun.

In using a bead weld to aid in starting the cut, the torch preheat flames are impinged against a vertical bead weld which joins all the plates. The cut is then started through the weld at the edge of the stack. This method is based on the fact that at the bead the stack is

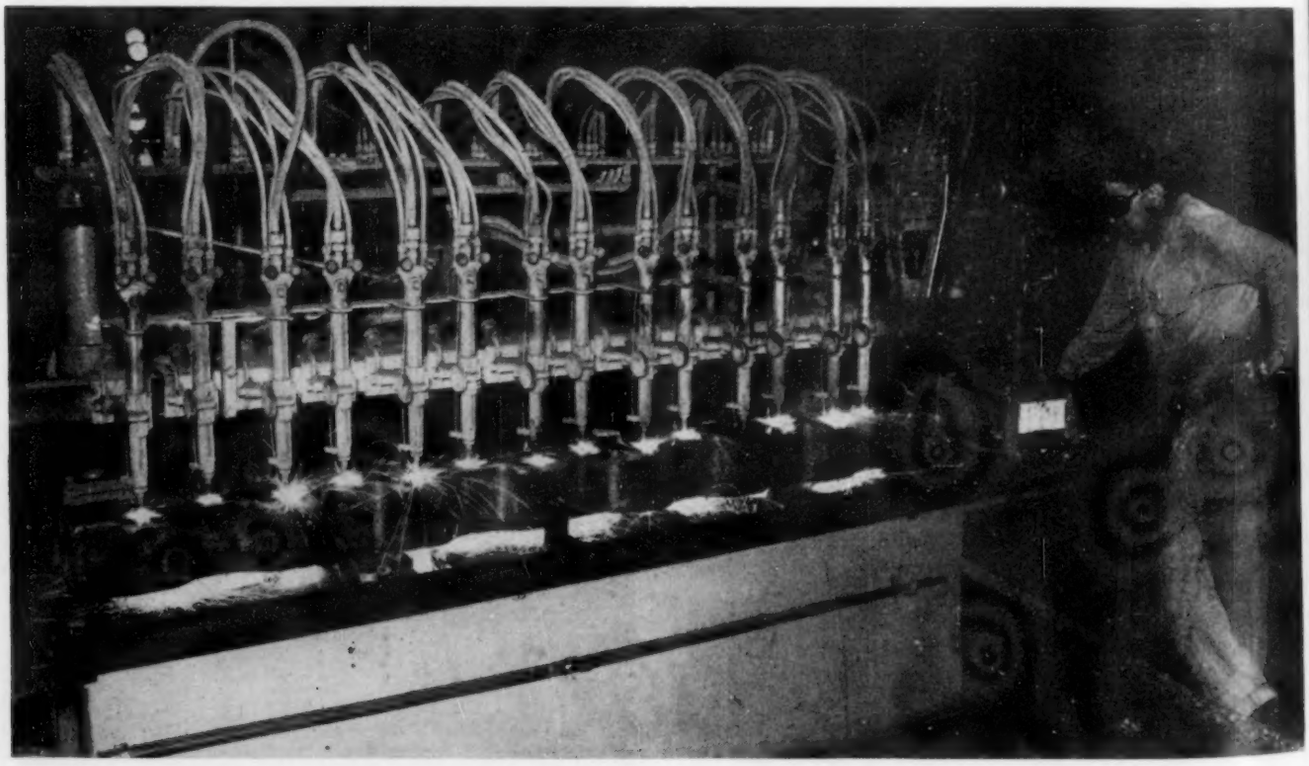


Fig. 11—Fourteen Torches Mounted on an Oxygraph Are Now Used to Cut All Openings in a Header at Once. Alternate Torches Are Spaced Out from the Torch Bar

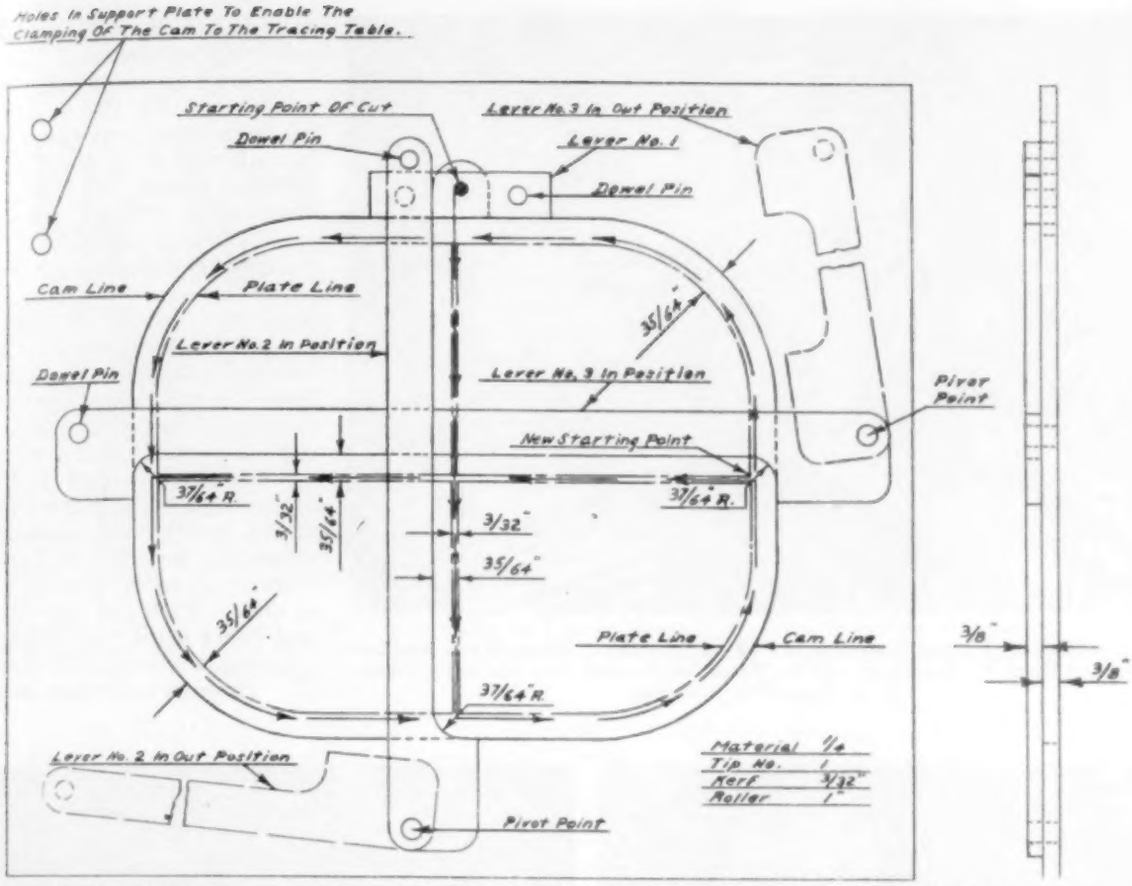


Fig. 12—Movable Gates in This Template Permit Four Identical Pieces to Be Cut Without Interrupting Progress of the Torch

not composed of individual plates but, by virtue of the weld, have been transformed into one homogeneous heavy plate.

There are also several steps to be avoided in stack cutting; viz., those producing an effect of heterogeneity of surface in face of cut. The most serious is an uneven, haphazard stacking of plates presenting an alternate, non-uniform pattern of overlapping and underlying edges of plates. (This should not be mistaken for the above mentioned "staggered pile" method with its uniform overlap.)

If the plates have been trimmed by mechanical shear, they may have the characteristic rounded edge; this also produces a negative condition for stack cutting. If the sheared plates are stacked so that the rounded edges are upward, the cutting flame tends to be deflected, causing a false start or cutting failure. However, if the rounded edges are face to face, open spaces are

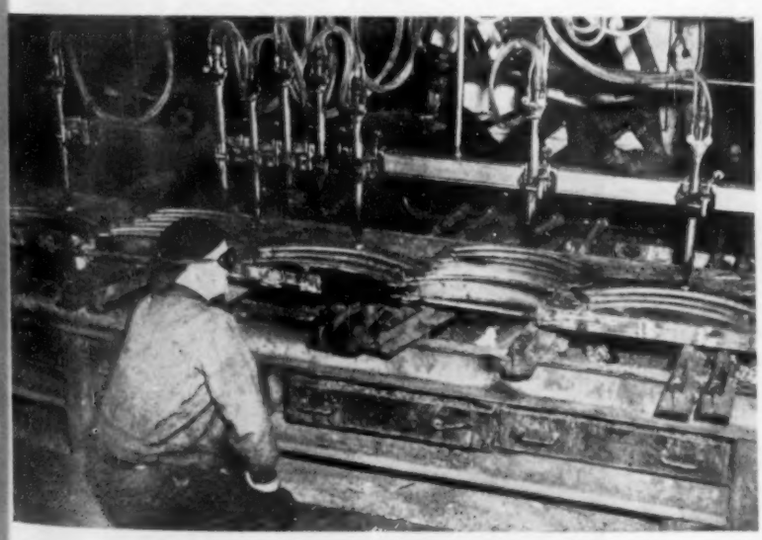


Fig. 13—Volume of Production Is Speeded in This Set-Up by Using Multiple Torches in Cutting a Stack of 5/16-in. Plates. Two and Three Torches Are Used Alternately in Making Five Rows of Cuts

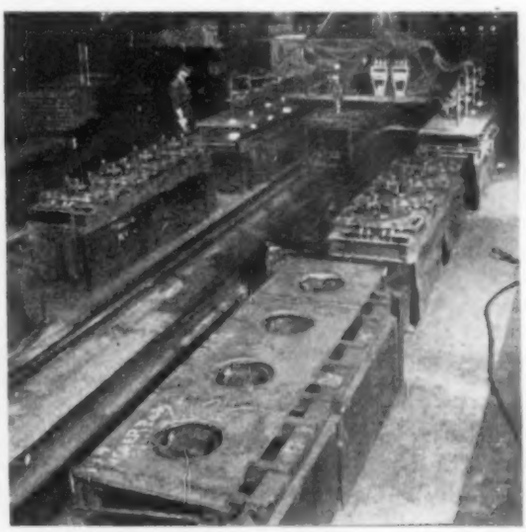


Fig. 14—Six Cutting Tables Are Used in Pairs, in Sequence, for Cutting Tank Sprockets in Rapid Production. Template Table Rides on the Travograph Tracks and Is Locked in Position at Each Cutting Station

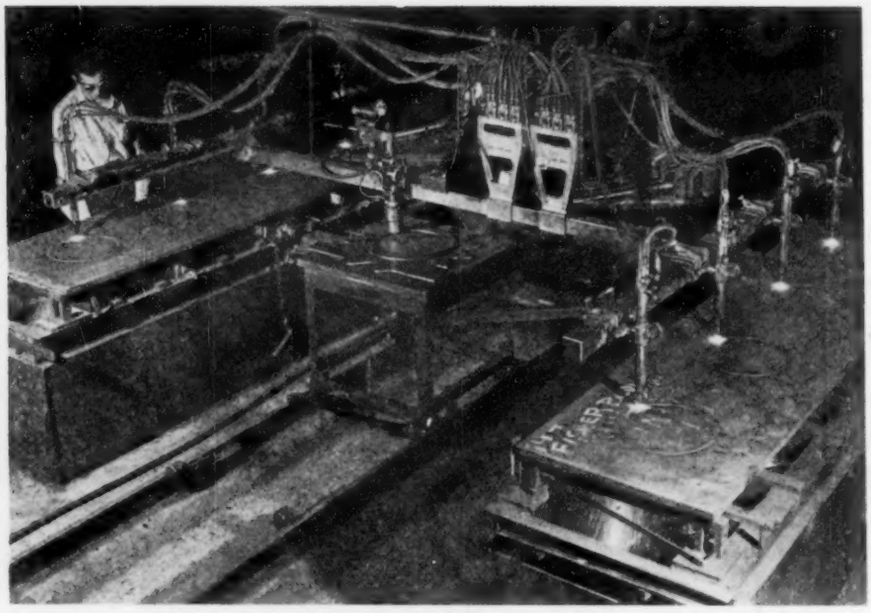


Fig. 15—Closeup of Initial Operation in Cutting Sprockets. Center Holes Are Cut at First and Third Work Stations, and the Plates Severed Into Four Pieces for Transfer to Center Pair of Tables

zation of the South is typified by t following experience.

Figure 9 shows the original arrang ment used for flame cutting 4 in. rectangular openings in the in. side-wall of a 6 x 6 in. sinuo tubular header of a marine ty steamboiler. Figure 10 shows typical header assembly. The set- consisted of a Camograph mounted a wheel base over a lathe bed wi measured "stops" for the prope progressive positioning of Camogra relative to header. This arrangeme served to meet all production requi ments—19 finished headers per 8-h day—for a period of 16 years.

Under the pressure of World W II demands for increased producti of ship power-units, a 10-torch Op graph was installed, and the 6 to holes required on a header were c at once. With the advent of larg and faster ships, the header size wa enlarged, similar to that shown in Fig 11. Through utilization of a custo

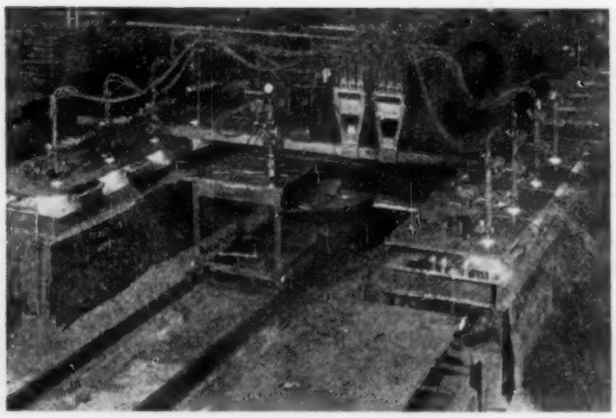


Fig. 16—Tooth Contours Are Cut on Eight Sprockets at Once, Using a Special Travograph with Crossbars at Each End of Torch Bar. Accuracy of Cutting Is Extremely High on This Setup

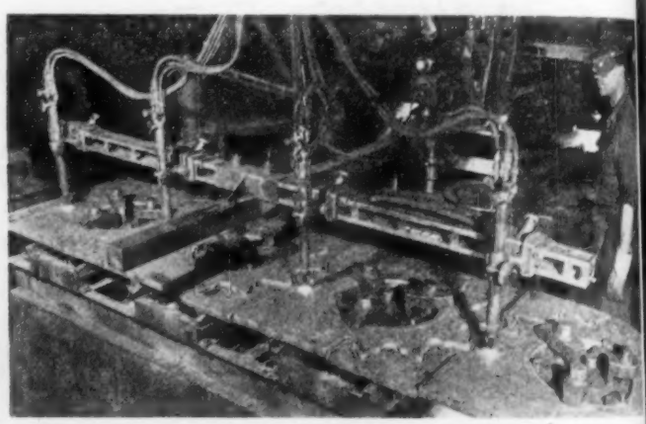


Fig. 17—This Close-Up of One End of the Machine Operation Shows the Central Clamping Jigs, with Each Piece Held Separately. Creep Is Thereby Reduced to the Vanishing Point

formed between the plates; normally the open spaces will stop the cut. When faced with this situation, the most practicable solution has proved to be the stacking of the sheared plates with rounded edges downward and, if possible, a flame cut plate at top of stack.

One of the principal applications of flame cutting is the shaping of component parts for welded assembly. Frequently these plates will be inner-cut, or holed-out, in addition to the peripheral or shaping cut. The starting cut of the holing-out operation is more difficult in stack cutting than in single-plate cutting. This is overcome by the use of a vertically drilled hole to serve as the point of origin of cut. Wherever possible, the drilling should be done after the plates have been stacked and clamped; if not, a bolt or drift pin should be inserted through the holes until stacking and clamping have been completed, to insure true alignment. After removing burrs, etc. to reduce the possibility of fouling the flame, the cut is started at the drilled hole, being careful to avoid false start.

The progress made within the past decade in the field of production flame cutting and in the increased industriali-

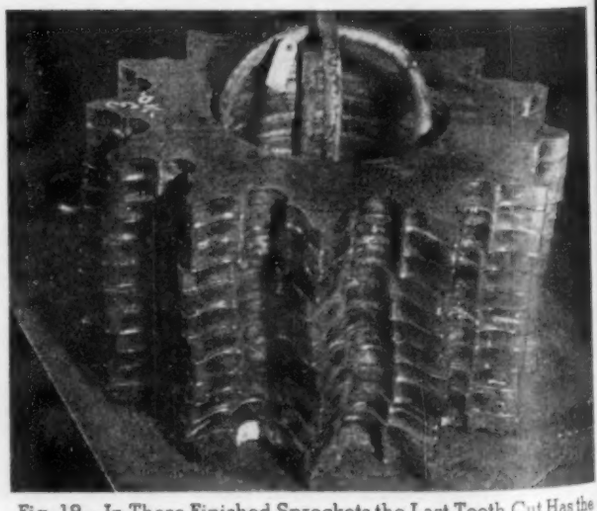


Fig. 18—In These Finished Sprockets the Last Tooth Cut Has the Same Shape as the Others, Indicating the Effectiveness of Individual and Central Clamping During Cutting

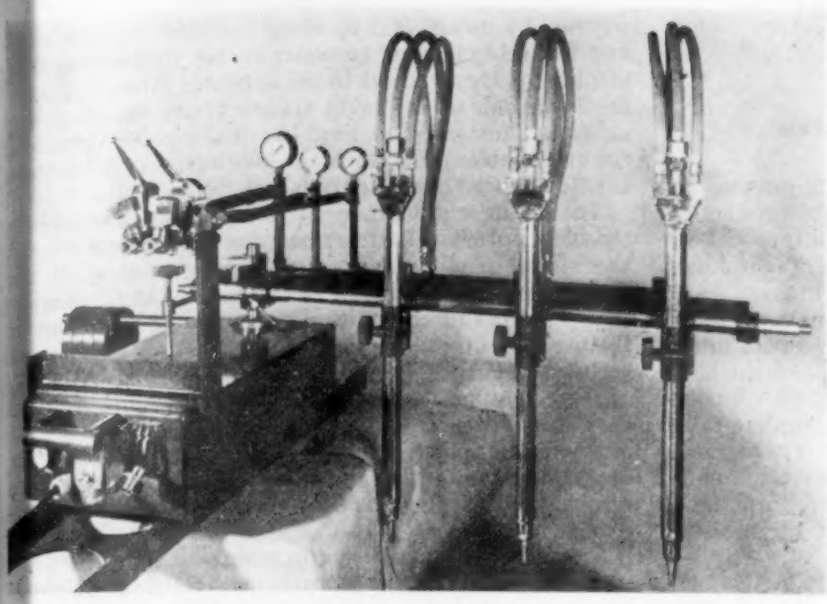


Fig. 19—The Heavy Duty Radiagraph No. 40 Was Designed for Cutting Steel Up to 50 Inches in Thickness, but Serves Numerous Other Functions as Well, Including Hot Cropping of Billets

built cutting machine, the production rate was increased to an average of 110 finished headers per 8-hr day; an increase of 450% in header production with no increase in the number of machines in service, notwithstanding linear increases of 67% and 133% in required cutting of the 10-opening and 14-opening headers, respectively.

Several unusual features are incorporated in the set-up. The application of multiple flame cutting is normally used to obtain parts of desired pattern from blank metal plates; however, in this instance, the parent piece is the finished product and the removed parts are scrap. Standard multiple cutting machines are constructed with the torches arranged in line, the cutting operation consisting of a multiplicity of adajcent cuts in reproduction of the template shape, but in the header-cutting machine, non-adjacent openings are cut in the parent piece. In this case, the lateral off-set is small, under 2 in.; however, it discloses the possibilities of this type of machine under more extreme application of the principle.

Figure 12 is a diagram of a special template for use with a magnetic tracer for the cutting of four identical pieces, and illustrates how nesting of pieces permits one cut to produce two adjacent finished edges. The following describes the method of application of the template:

Lever No. 1 is moved into the out-position to permit start of cut which progresses forward along lever No. 2 until the magnetic roller reaches main cam outline, at which time lever No. 2 is moved into the out-position. While cut is in progress on main cam, lever No. 3 is moved to the in-position to complete the cut of two of the four pieces. (Follow arrows.) When this cut is finished, lever No. 3 is moved into the out-position. The magnetic roller is then moved to the new starting point. Before this cut is started lever No. 1 is to be moved to the in-position as shown. The magnetic roller then progresses to complete the cutting of the two remaining pieces.

One of the latest developments in production cutting can be seen in Fig. 13. This set-up incorporates the features of both stack cutting and multiple cutting and as such, is capable of extremely high production. The machine is employed by a large East Coast shipyard for the cutting of arcs of large diameter rings. The Oxygraph uses an alternate two-torch and three-torch combination. The first phase of the operation is the cutting of two rows of arcs from the stack of nine $^{5}/_{16}$-in. plates by No. 2 and No. 4 torches, then the alternate rows are cut by torches Nos. 1, 3 and 5. The plates are held together by tack welds spaced at approximately 10 in. As shown in the figure, $^{3}/_{4}$ in. square bars are welded along the edge of the stack at the end of rows Nos. 2 and 4 to effect a continuity of stack after actual severance by the cutting of the first two rows. The division of the cutting operation into two distinct parts is not due to limitations imposed by the machine; this procedure is followed to prevent high heat and stress concentrations, and plate distortion. By utilizing the alternate method of cutting, less heat is applied to the stack during a course of cutting and thus the accumulated heat can be dissipated more readily through conduction and radiation.

Several years ago, industry was faced with the staggering task of transforming the extremely large National Defense appropriations into actual weapons of warfare. One of the largest tasks of the automotive industry was the design and mass production of self-propelled armored vehicles, tank destroyers, half-tracks and all the various models of tanks. The fact that the automotive industry fulfilled their assignments in a manner excelled by no other can be attributed in no small way to the new and advanced application of flame cutting processes.

Among the outstanding instances of refinement of procedure in machine cutting is its application in the production of tank sprockets. The sprockets made from S.A.E. 4140 steel, are $1^{1}/_{2}$ in. in thickness and approximately $27^{1}/_{4}$ in. in outside diameter. After preheating to a temperature of 300 to 400° F. to prevent check cracks the plates are moved from the heater to a Travograph. This machine is equipped with four extra-long torches in order to get the torch-bar away from the heat. Various tips were first tried to determine the most effective; finally it was found that a No. 2 or No. 3 tip with medium preheat proved to be the best, utilizing pressures of 50 lb. for oxygen and 3–4 lb. for acetylene at a speed of 10–11 in. per minute. The total time of operation is approximately 40 minutes, 20 minutes set-up time and 20-minute cutting time.

After the cutting is completed, the sprockets are annealed for $2^{1}/_{2}$ hr. at 1650° F. It was found that considerable care was required in handling the sprockets while hot to avoid distortion. However, when this oc-

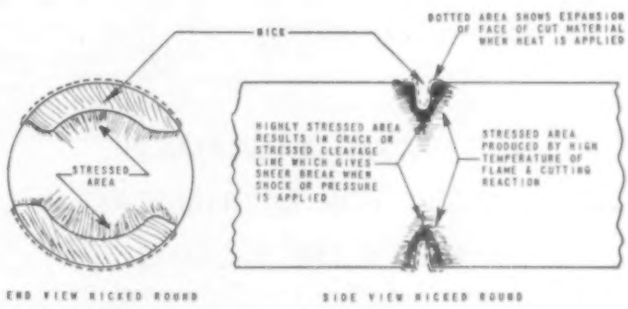

NICK
DOTTED AREA SHOWS EXPANSION OF FACE OF CUT MATERIAL WHEN HEAT IS APPLIED
STRESSED AREA
HIGHLY STRESSED AREA RESULTS IN CRACK OR STRESSED CLEAVAGE LINE WHICH GIVES SHEER BREAK WHEN SHOCK OR PRESSURE IS APPLIED
STRESSED AREA PRODUCED BY HIGH TEMPERATURE OF FLAME & CUTTING REACTION
END VIEW NICKED ROUND
SIDE VIEW NICKED ROUND

Fig. 20—Round Bar Showing Stress Induced by Nicking Cold Steel of 0.35 Carbon and Over. The Same Effect Occurs in Nicking Square Billets

curs, they are leveled and rounded into shape before being machine-ground to final dimensions.

Precision Cutting of Tank Sprockets

The great progress made in precision flame cutting can be shown in its most recent application to the production of M-4 tank sprockets. In contrast to the process described above, the precision principles now employed eliminate the necessity of subsequent machining.

A No. 30 Travograph with special arms carrying 4 torches on each side, travels between three pairs of tables placed end-to-end, parallel, and on each side of the path of the cutting machine, as illustrated in Fig. 14. To permit the use of dual torch-arms a small template-table was built to run on the same tracks as the Travograph. Since it is essential that the table and template be rigidly fixed during cutting operations, adequate fixtures have been provided for anchoring this table at each of the three working positions.

A $1^1/_4$ in. x 28 in. x 8 ft. 11-in. steel plate (S.A.E. 1345) is placed on each of the first pair of tables. In each plate four starting holes are pierced by the use of a hand torch, after which the machine is used to cut out the center or hub-holes of the sprockets, and then to sever each plate in four pieces. The Travograph is then moved to the third pair of tables which have been similarly loaded, and the same operation performed as shown in Figs. 14 and 15.

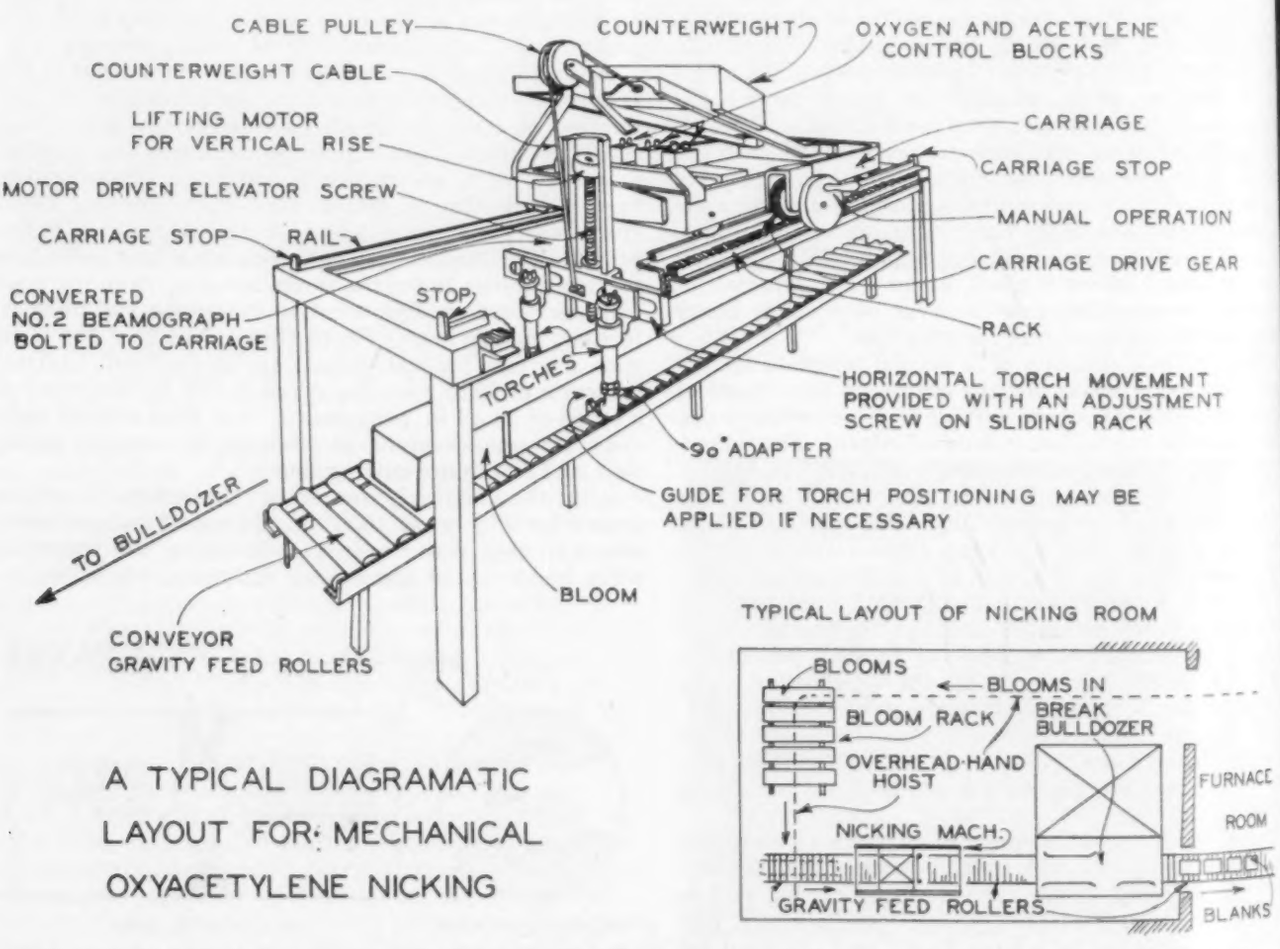
In the meanwhile, the severed plates from the first tables are transferred to the center tables, accurately positioned by means of a jig using the flame-cut hub-holes and securely clamped to water-cooled jig fixtures. The machine is then moved to these center tables where the tooth-contour of the eight sprockets are cut simultaneously as illustrated in Fig. 16. During this operation, the other tables are again loaded with plates. These steps can be followed by comparing Figs. 14 and 16.

The greatest advantage of this precision process over the older, previously described one is the elimination of the subsequent machining operations, frequently the limiting production factor. The increment of accuracy that permits this elimination of machining is attained by the use of center-clamping, water-cooled jig fixtures and high-speed cutting tip No. 45, No. 4, as shown in Fig. 17.

This clamping arrangement restrains the sprocket or gear from the walking action inevitably present if clamps are applied externally, that is, to the scrap. In center clamping, the walking action is transferred to the scrap, permitting cutting of the sprocket to a 0.033 in. tolerance.

The high speed cutting tip, using an acetylene pressure of 8 lb. and an oxygen pressure of 100 lb., permits a cutting speed of $8^1/_2$ in. per minute, or a cutting time of 13 minutes for the circuit around the sprocket. With this high speed of cutting, and efficient handling and control of material, a production of 14 sprockets per hour or 112 per 8-hr. shift is attained.

Figure 18 shows a number of sprockets after the final cutting operation. After cutting, the sprockets are stress relieved in furnaces and then the sprocket teeth are flame hardened by means of a semi-automatic oxy-acetylene machine to secure better wearing qualities.



A TYPICAL DIAGRAMATIC LAYOUT FOR MECHANICAL OXYACETYLENE NICKING

Fig. 21—Schematic Diagram of Typical Layout for Mechanical Oxyacetylene Nicking of Billets in Production of Shell Stock Blanks

Heavy Duty Radiagraph

Figure 19 shows the latest development in portable cutting machines, known as the Heavy-Duty Radiagraph No. 40. This multitorch machine was designed to carry the special cutting torches required for penetrating and severing steel 18 to 50 inches or more in thickness. It has a wide range of speeds, from 1 in. to 44 in. per minute, operated through a gear transmission and gear-shift lever. The heavy duty torches are a newly developed series, water cooled and designed with their auxiliary equipment to carry extremely large volumes of gas per hour.

While designed primarily for heavy cutting operations at low speeds, the machine may also be used for hot cropping and cut-off of billets and blooms at the mill. Several billet cutting setups are in service in steel mills and have attracted considerable attention. In such installations the flame cutting apparatus serves either as a substitute for shears, particularly in cases where the steel being rolled is heavier than the available shears can handle, or as standby equipment to take care of billet cutting in case of shear breakdown. Multiple torches have been employed to maintain the pace of production in several of these set-ups.

The gear transmission system of the heavy duty Radiagraph is of particular interest, inasmuch as its incorporation in a flame cutting machine marks a new advancement in cutting equipment. It consists of a gear reduction unit, a transmission unit, and interchangeable spur gears, powered by a variable speed motor. In contrast to the smaller portable machines, the top is clear and unencumbered, permitting any kind or amount of cutting, hardening or multiflame automatic gas welding apparatus to be mounted thereon. This broad range of application makes the machine one of the most versatile yet designed, since there is no oxyacetylene operation outside its range. One of its current applications is as the motive power unit in the billet necking machine illustrated in Fig. 24.

Billet Nicking Machines

The present armament program requires the speedy and economical production of millions of shells and bombs. During World War I, the oxyacetylene process of nicking and breaking proved to be the cheapest, speediest and most practical method for the production of stock blanks from square or round bars, billets or blooms. In this war, manufacturers having huge contracts for

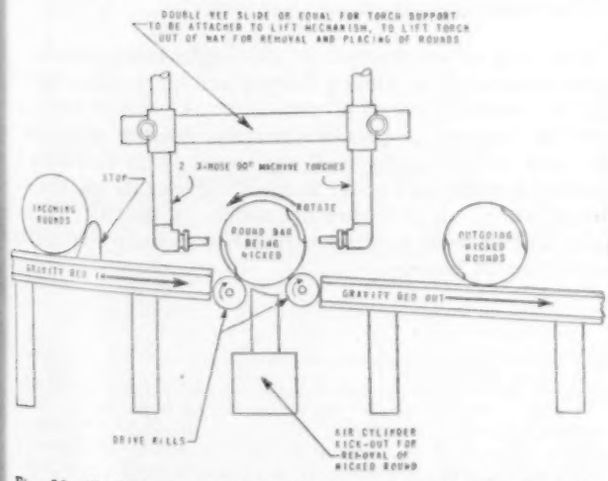

DOUBLE VEE SLIDE OR EQUAL FOR TORCH SUPPORT TO BE ATTACHED TO LIFT MECHANISM. TO LIFT TORCH OUT OF WAY FOR REMOVAL AND PLACING OF ROUNDS
2 3-HOSE 90° MACHINE TORCHES
STOP
INCOMING ROUNDS
ROTATE
ROUND BAR BEING NICKED
OUTGOING NICKED ROUNDS
GRAVITY BED IN
GRAVITY BED OUT
DRIVE ROLLS
AIR CYLINDER KICK-OUT FOR REMOVAL OF NICKED ROUND

Fig. 22—End View of Schematic Layout for Nicking Rounds

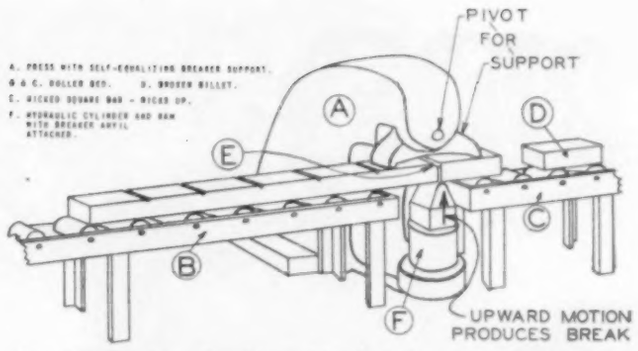

A. PRESS WITH SELF-EQUALIZING BREAKER SUPPORT.
B & C. ROLLER BED.
D. BROKEN BILLET.
E. NICKED SQUARE BAR — NICKED UP.
F. HYDRAULIC CYLINDER AND RAM WITH BREAKER ANVIL ATTACHED.
PIVOT FOR SUPPORT
UPWARD MOTION PRODUCES BREAK

Fig. 23—Machine Breaking of Nicked Square or Round Bars, Using Hydraulic Press with Self-Equalizing Support

shells have again adopted this process of nicking billets with the oxyacetylene torch and then breaking with either drop hammers, bulldozers, hydraulic presses, or dropping onto an anvil and letting the shock cause the fracture and severance.

Several different nicking procedures are being employed, all, of course, subject to modification as greater experience is gained.

The nicked, or grooved surface and the added stress set up by the oxyacetylene nicking process along the cleavage line makes possible the production of stock blanks with sheer breaks by the simple application of pressure and/or shock. As the steel analysis used for shells is of a specification that will fragment properly upon bursting, this property is taken advantage of in the nick-and-break process.

The application of the flame, along with the localized high-temperature resulting from the cutting reaction, causes expansion of the metal, and due to the restraining action of the base metal, the metal adjacent to the cut is upset. This effect, combined with the quench action of the cold mass of metal causes the adjacent areas to be highly stressed. When the elastic limit is exceeded, a crack is produced or can be started by the application of shock or pressure.

The result obtained by nicking on both sides of a round or square cold steel bar or billet of carbon 0.35 or over is illustrated in Fig. 20.

There are no special provisions in the ordnance specifications of the U.S. Army or Navy regarding procedure of severance. However, the required inspection procedure specifies that at least one end of a shell blank be provided with a square, natural surface. This would, therefore, seem to eliminate shearing, sawing or cutting on one end at least, and would automatically prescribe the nick-and-break process.

Billets may be readily nicked by the hand torch, but where the entire faces of two opposite flats of a square billet require nicking, it is best accomplished by means of machine torch equipment. The latter method provides a means of rapid and economical production of straight, opposite nicks of a predetermined depth, resulting in clean, square breaks under the press.

The nicking machine consists of a motorized torch fixture for the quick positioning of two torches at predetermined points on a square billet, with tips directed toward the bottom corner of the billet at an angle of 45 to 90° as shown in Fig. 21. The nicking operation is completed so rapidly that excellent handling facilities must be provided to obtain full advantage of the equipment. In some instances a hand hoist with electromagnet is used for moving billets to a gravity roller-table such as shown in Fig. 22.

Steel mills provide blooms or billets hot-sawn to lengths of multiples of those desired for the shellstock

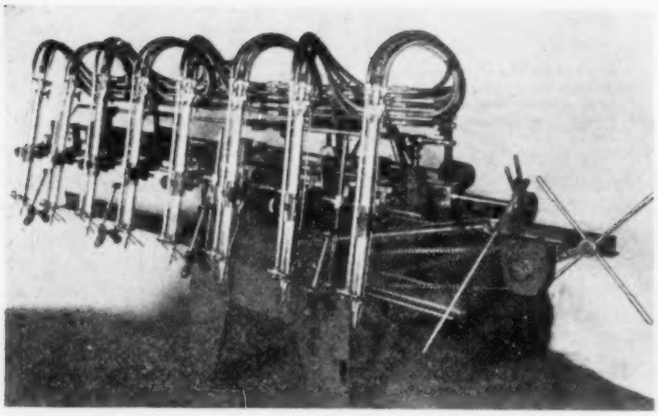


Fig. 24—Latest Type of Billett Nicking Machine. Nicks Are Made Horizontally Across Top Face of Billet. Double Casters Maintain Proper Space Between Torch Tip and Work. Note Quench Jets on Both Sides of Each Tip

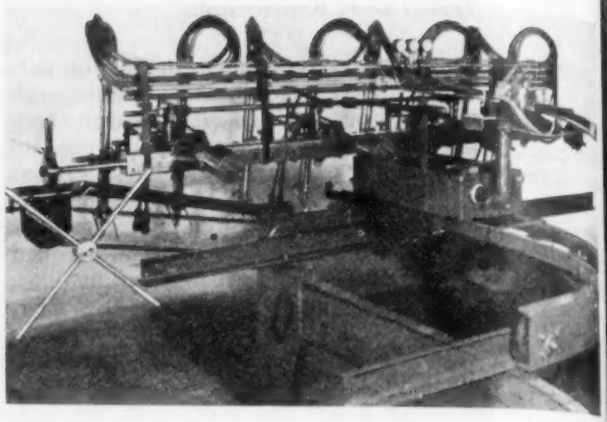


Fig. 25—Rear View of Machine Shown in Fig. 24. Torches Are Driven by a Heavy-Duty Radiagraph, with Tracks Mounted on a Gantry for Lateral Adjustment

forging blanks with allowances made for the kerf widths. The shellstock blank lengths can be accurately held to any predetermined length by marking nick locations on the billets, or by the use of a stop and index box on the carriage of the machine. The bed of the nicking machine should be of sufficient length to permit the entire length of a bloom or billet to be covered and all nicks completed at one setting by merely moving the machine progressively from one nick position to another.

Upon completion of the nicking operation the two operators release the stop, permitting the billet to be pushed into a gravity roller bed to move it forward as shown in Fig. 23 to the breaking machine. As the billet is broken into shell-stock blanks, the pieces are moved on gravity rollers to the furnace or to storage.

Figure 24 shows the latest development for machine billet nicking. As industry was called on to meet the greatly expanded demand for large caliber field artillery shells, means of faster production was found necessary. This new machine differs from the former in several notable respects. In contrast to the older types, this machine permits two, four, six or eight nicks to be made simultaneously on the top side of the billet, torch movement being horizontal instead of vertical. Control of the vertical position of the torches is by caster-fixtures riding on the top of the billet, producing accurate, predetermined nick depths regardless of camber or irregularities in billet shape. Each caster-fixture controls the height of a set of torches. The fixture consists of two casters with the leading caster several inches ahead of the torch tip, the trailing caster several inches back of tip. At the beginning of the nick, the leading caster alone rides on the billet. About midway across, both casters make contact, and as the nick nears completion the leading caster has ridden off the billet and the trailing caster alone maintains torch elevation.

Another unique feature incorporated in the new machine is the water-quench jets attached to the torches. The jets of water issue from pipes almost immediately following the cutting jets, causing a quenching action which increases stress concentrations at the nick-line by increasing the temperature differential. The water is brought to the jet-pipes by $^1/_2$-in. pipe along the torch and $^1/_2$-in. hose from this point to the plant water system. The flow of water is controlled by a toggle valve adjacent to the gas control valves behind the machine. Pilot flames are provided at each torch.

The handwheel with sprocket attachment shown at the right in Fig. 24 controls lateral adjustment, by which the machine is moved to the right or left until a metal pointer, also shown in Fig. 24, is at end of billet. This places the torches in the proper position to nick the billet according to the length of stock-blank required for the specific caliber of ammunition under manufacture. The force applied to the handwheel is transmitted by sprocket chain to one of the running wheels of the gantry upon which the entire machine is mounted.

The following data provide operational details of the machine:

Shell Size	155M
Shell Stock Blanks	6 x 6 x $12^1/_2$ in.
Tips	Style 118, No. 2
Oxygen Pressure—Preheat	35 lb.
Oxygen Pressure—Nicking	8–10 lb.
Acetylene Pressure—Nicking	12 lb.
Preheat Time	5 Sec.
Nicking Time	12 Sec.
Length of Nick	5 in.
Depth of Nick	$^1/_4$ in.
Oxygen Consumption—per torch	150 cu.ft./hr.
Acetylene Consumption—per torch	37.5 cu.ft./hr.
Oxygen Consumption—per nick	0.71 cu.ft.
Acetylene Consumption—per nick	0.18 cu.ft.

The rate of production of the eight-torch machine is approximately 760 nicked blanks per hour, when operating at a work factor of 40 per cent. At higher work factors the output is proportionately greater and, unless the mill is unusually well equipped with facilities for heating, forging and other succeeding operations, the output of about eight hours operation of the nicking machine will provide sufficient material to keep the mill occupied for 24 hours.

High Lights of Hard-Facing Procedure*

By R. L. Lerch†

HARD-FACING of wearing parts to prolong their life assumes greater importance than ever before in these days when it is so necessary to keep all-important machinery in operation every minute. The technique for hard-facing with hard-facing alloy rod is quite simple, as every experienced welding operator knows, if a few basic procedures are borne in mind. The more important of these are:

1. Thoroughly clean a surface before trying to hard-face it.
2. If a hard-faced edge or corner will be subject to shock, prepare it as shown in Fig. 1.
3. Preheat to a faint red heat, visible in a darkened room only, without goggles.
4. Always use an excess-acetylene flame. (See Fig. 2.)
5. Do not apply the hard-facing alloy before the surface of the base metal reaches the "sweating" temperature.

* Article written with special reference to the use of Haynes Stellite Hard-Facing Rod. Figures on savings and increased life are based on the use of this material.

† Vice-President, Haynes Stellite Co.

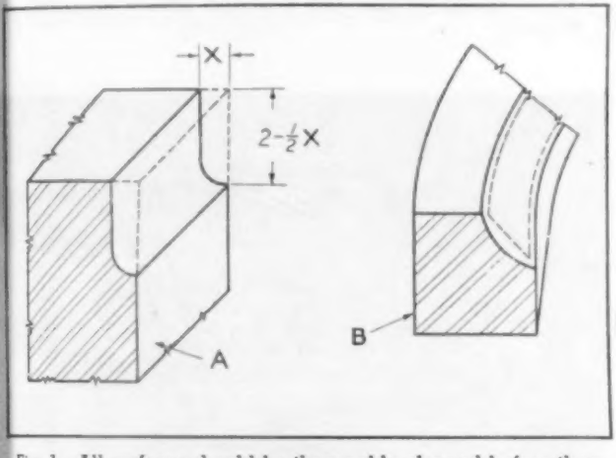


Fig. 1—All surfaces should be thoroughly cleaned before they are hard-faced. A corner or edge that will be subject to shock, as on a punch, a shear blade or a die, should be machined as shown at *A*. An angle or inside corner that will be subject to mild impact only such as a valve seat, should be machined as shown at *B*. Dotted lines indicate finish ground dimensions of the hard-facing alloy

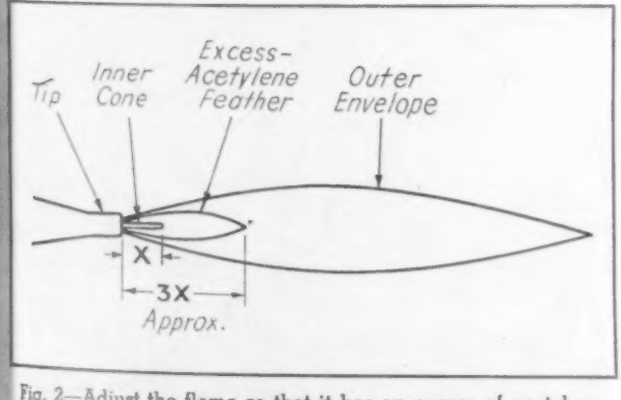


Fig. 2—Adjust the flame so that it has an excess of acetylene as indicated by a bright secondary flame, called a feather, surrounding the inner cone. For hard-facing with hard-facing alloy rod the feather should be three times the length of the inner cone. If an excess-acetylene flame is not used the alloy will not spread uniformly and may become porous

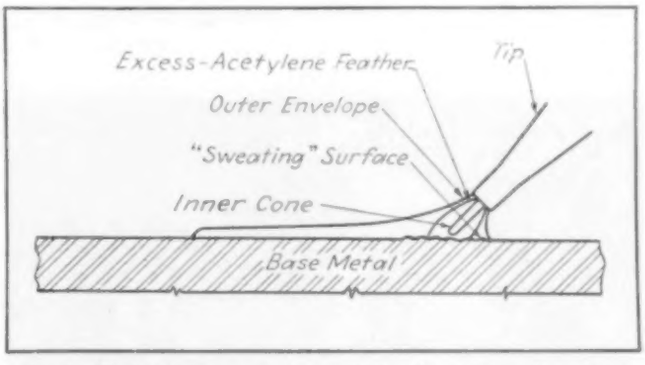


Fig. 3—With the inner cone about ⅛ in. from the surface, heat a spot of the base metal until it suddenly becomes glazed, indicating that an extremely thin surface layer has melted. This condition, which can be produced only with an excess-acetylene flame, is known as "sweating" and is necessary to the successful application of alloy hard-facing rod. The "sweat" area will extend for a distance of about ¼ in. around the acetylene feather

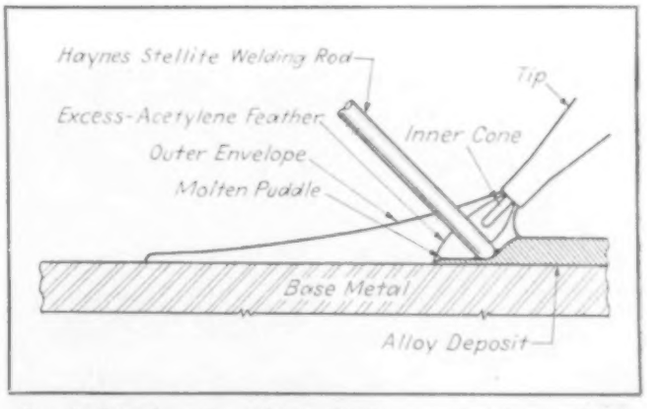
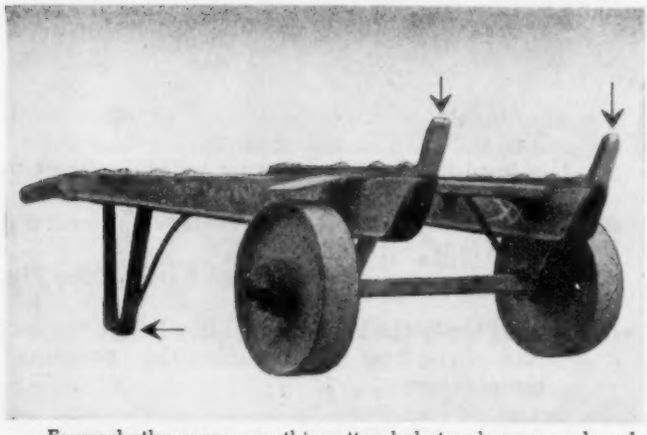


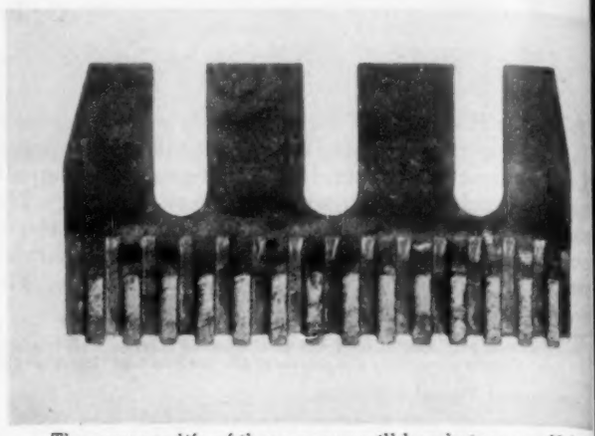
Fig. 4—Introduce the rod into the flame so that the tip of the inner cone just about touches the rod and the rod lightly touches the "sweating" metal. The end of the rod will then melt and form a puddle on the surface of the "sweat" area. Withdraw the rod and spread the puddle with the flame. Do not stir the puddle. Melt off more rod as required. If the flame is directed partly on the puddle and partly on the metal adjoining the puddle, the operation will progress forward

6. Hold the rod and blowpipe tip each at an angle of about 45° to the work. (See Fig. 3.)
7. Let the end of the inner cone almost touch the rod.
8. Do not stir the molten puddle with the rod.
9. Never cover over or embed any foreign particles in the deposit. Float and remove them or they may cause blowholes.

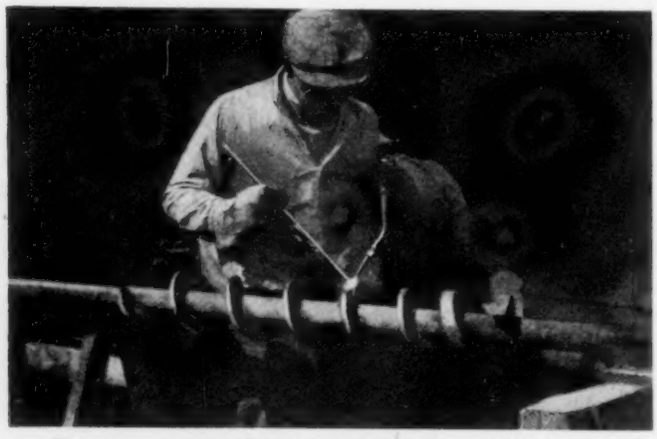
Typical Hard-Facing Applications



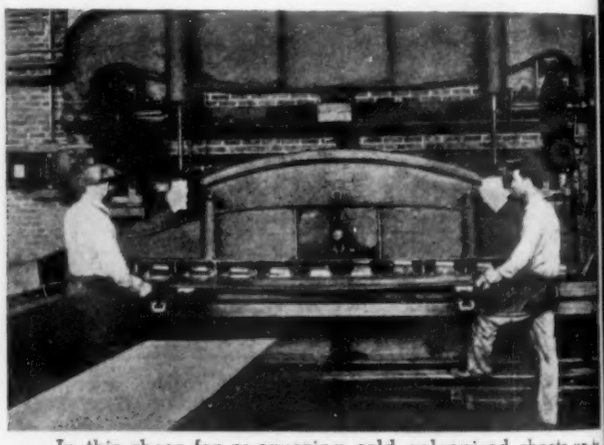
Formerly the prongs on this cotton bale truck were replaced 3 times a season and the skids 6 times. After being hard-faced they show little wear at the end of a year of service.



The average life of these paper mill hog knives was 20 days during which 4 removals for regrinding were necessary. When hard-faced they last 7 months without regrinding or refacing.

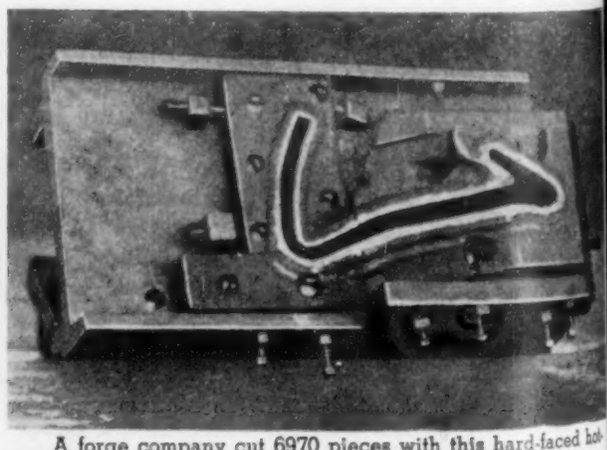


The average life of screw conveyors in a Michigan rock products plant was 5 weeks. A hard-facing alloy deposit of $7^1/_2$ lb. on the flights of three 6-in. conveyors increased their life to 25 weeks at a saving of $512.55.

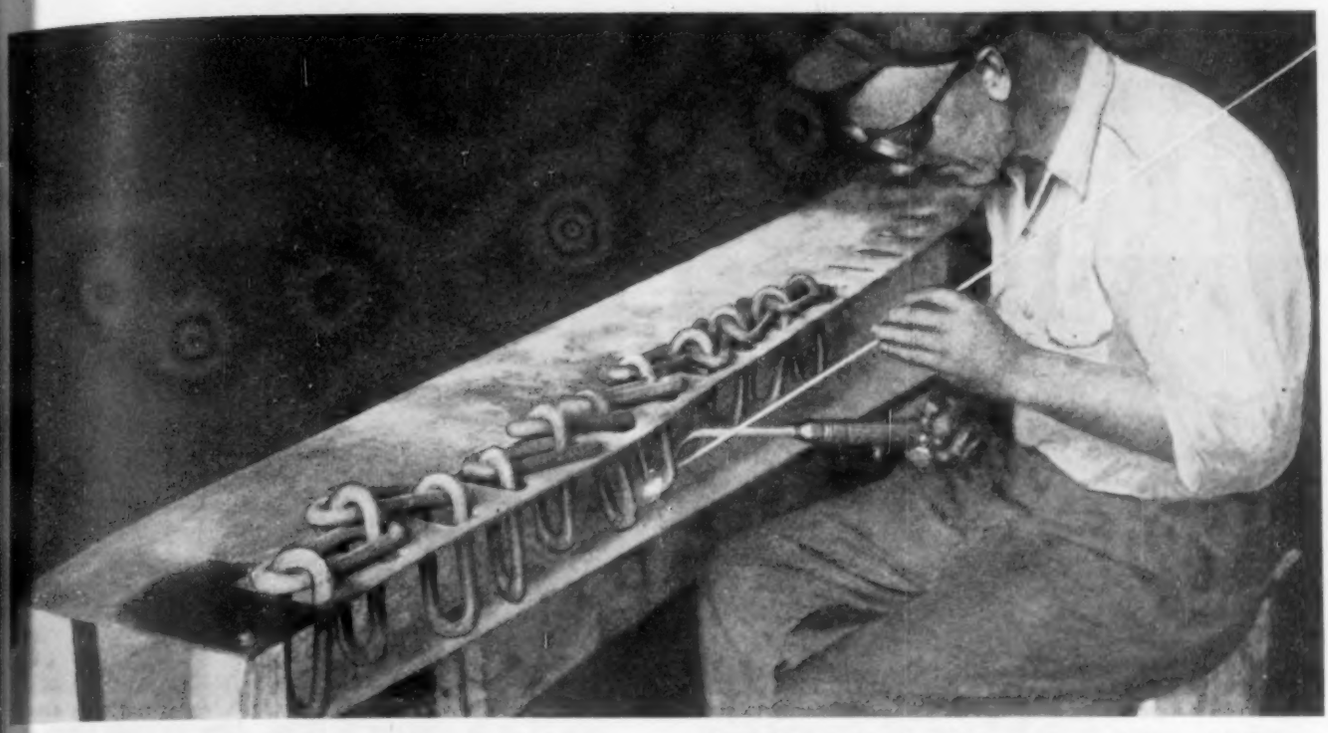


In this shear for re-squaring cold galvanized sheets up to $^1/_8$ in. maximum thickness, hard-faced blades last 2 to 3 times as long between grinds as the hardened steel blades formerly used.

Hard-facing alloy applied to the tip of undercutter bits in a coal mine effected a saving of 50% in bit cost and from 22 to 27% in power consumption.

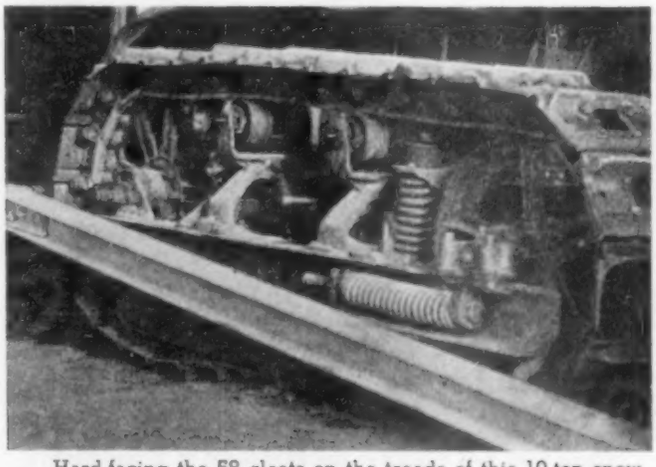


A forge company cut 6970 pieces with this hard-faced hot-trimming die. Previous to the use of hard-facing alloy, a carbon tool steel die averaged only 500 pieces, or one-fourteenth as many.

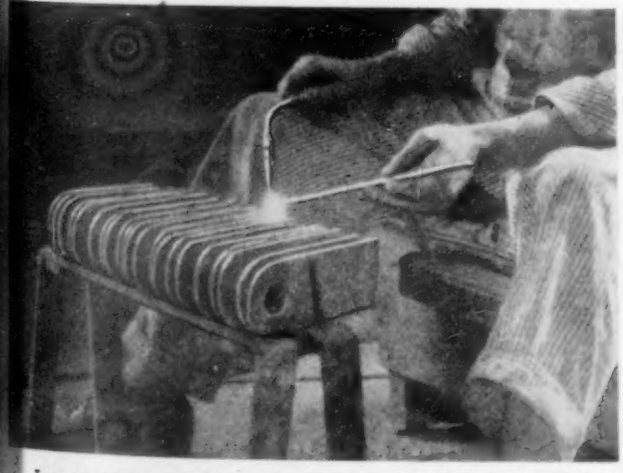


A Small Deposit of Hard-Facing Alloy Inside Each End of the Links of a Conveyor or Drag Chain Will Increase Its Life from 3 to 5 Times

The gudgeons, $2^{15}/_{16}$ in. in diameter, on this cement conveyor lasted but 3 months prior to hard-facing. A hard-faced gudgeon after 1 year and 10 months of service was worn down only $^{1}/_{32}$ in. on its diameter.



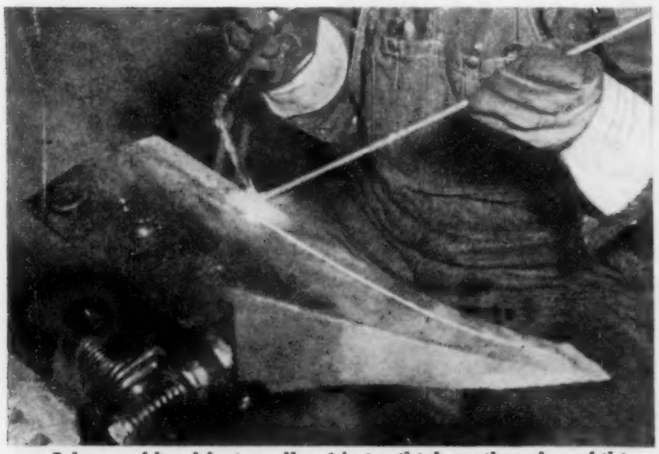
Hard-facing the 58 cleats on the treads of this 10-ton snow shovel tractor saved a Midwest highway commission over $650 in one winter. Besides the savings in dollars, the hard-faced treads afforded better traction.



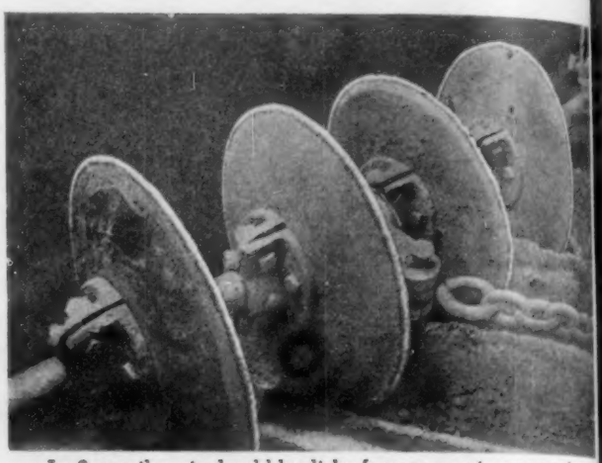
In one day, a welding operator can hard-face about 500 alfalfa mill hammers with hard-facing alloy at a cost of approximately 10 cents each, thereby increasing their length of service at least 10 times.

Only about 2 oz. of hard-facing alloy are required to hard-face the hob-nails for a pair of work shoes but their average life of 5 or 6 months will be increased to a year and a half.

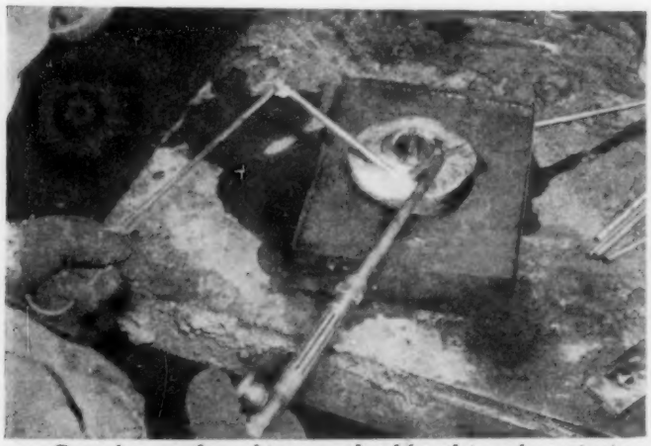
10. Complete the operation in one pass if possible. Do not deposit successive layers of alloy unless absolutely necessary.
11. Remove the flame from the puddle slowly and with a circular motion.
12. Cover the finished job with asbestos paper or bur in powdered mica, lime or ashes so that it wi cool slowly.



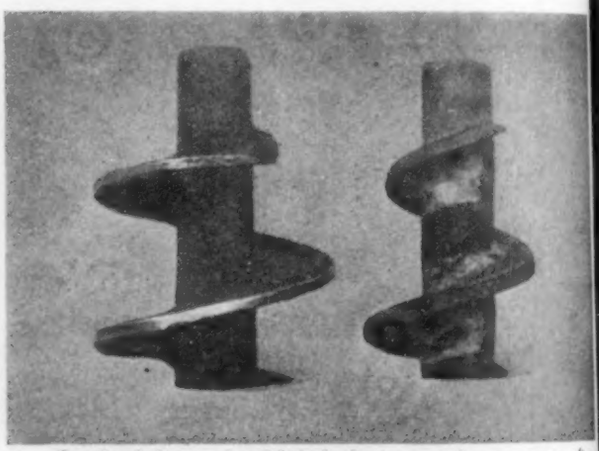
A layer of hard-facing alloy $^1/_{16}$ in. thick on the edge of this plowshare increased its life by 5 times and eliminated delays and the inconvenience of sharpening during the plowing season.



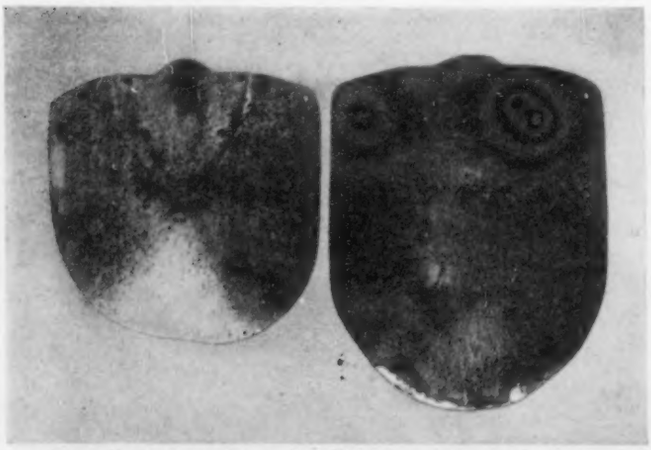
In 6 months, steel rabble disks for ore roasters wear down from 18 in. in diameter to 11 in. After an equal length of service, disks hard-faced with hard-facing alloy show practically no wear.



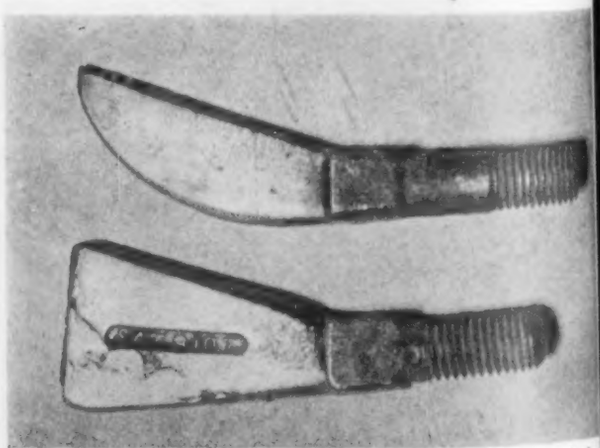
Cams from nail machines are hard-faced in a few minutes at a cost of $5.00 each. It required several hours to machine and case-harden the S.A.E. 1010 steel cams formerly used, at a cost of $20 each.



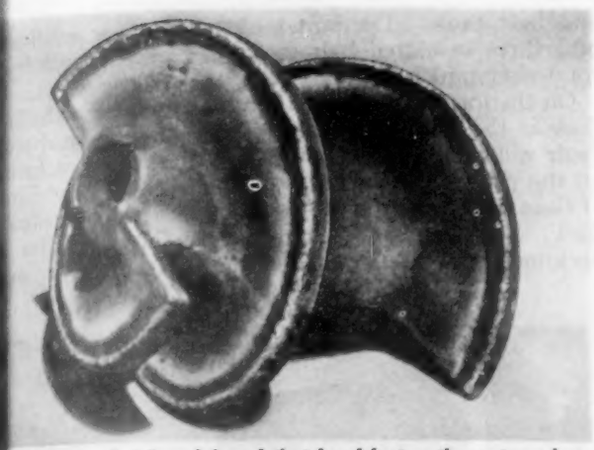
On the left is a hard-faced electric mud gun screw after 4 months of service. On the right is an ordinary screw after 1 month of service. These screws are used for closing the tap hole of a blast furnace.



This illustration shows the difference in wear between an ordinary shovel and one edged with hard-facing alloy. The hard-facing is applied in a band $^1/_4$ to $^3/_8$ in. wide along the under side of the point.



These threshing machine cylinder teeth operated side by side for 30 days; the lower one, hard-faced, shows practically no wear; the upper one is worn beyond economical repair.



A western brickyard found that hard-facing the outer edge of cast-steel mixing augers with hard-facing alloy doubled their usual life of 45 days to 90 days at a cost about one-fourth that of new ones.

A chemical company standardized on hard-faced coal pulverizer hammers after the first set, faced with hard-facing alloy, pulverized 223,000 tons as compared with 38,000 tons for the tool steel hammers formerly used.

Tuna Clippers

By S. R. Zimmerman

AMONG the people on the water front the question is—"What are fishing craft going to be like after the war?" The answer is that they are going to be faster, more graceful, more economical and more comfortable. There will be lots of boats of every description to suit every pocketbook and every desire, both for pleasure and for commercial purposes. This answer is provided not by blueprint specifications and drawing board theories, but by actual production now under way in various shipyards. Right now there is on the ways an all-steel tuna clipper, being built by the Steel Shipbuilding Division of the United Concrete Pipe Corporation, which is typical of the strides forward in the small shipbuilding industry.

The tuna clippers now in production at Long Beach shipyard of the United Concrete Pipe Corp. are all-steel construction with the exception of wooden joiner work in the deckhouses and the hold insulation, which will be cork. The crew's quarters will be insulated with spun glass. The vessels are incorporating the most modern but proved ideas, such items as unusually good ventilation, a fidley permitting plenty of light, and air, and an inside passageway from deck to engine room.

Fig. 2—Under Way in the Los Angeles Harbor is a U. S. Army Vessel Built by the Steel Ship Division of the United Concrete Pipe Corp.

This picture was taken on the trial run of these vessels which are 176 ft. long with a 31 ft. beam and are rated at 14 "plus" knots.

The principal dimensions of these single-screw tuna clippers are:

Length over all	131 ft. 0 in.	
Length on load water line	126 ft. 9 in.	
Length between perpendiculars	119 ft. 9 in.	
Beam molded	27 ft. 0 in.	
Depth molded	14 ft. 5 in.	
Brine well capacity under deck	9840 cu. ft.	256 tons
Brine tank capacity on deck	2160 cu. ft.	54 tons
Total fish tons capacity		300 tons
Diesel engine fuel oil capacity		40,000 gal.

General Description

A profile view of these vessels shows that they are the raised-deck tuna clipper type of design. They have a raked stem. The stern is of true cruiser construction and thus is more slender than the modified stern used in many fishing boats. The hull is of electric welded ship plate, varying in thickness from $^3/_8$ to $^1/_4$ in. The stern fram (that part of the ship attached to the after end of the keel to form the ship's stern and including the rudder post, propeller post and aperture for the pro-

* Asst. to Admin. Mgr. United Concrete Pipe Corp., Steel Shipbuilding Division, Long Beach, Calif.

Fig. 1

Doris Logan, left, and Mildred Seiler give their approval to the scale model of the all-steel tuna clippers being built by the Steel Ship Division of United Concrete Pipe Corp. The first of four tuna clippers will soon see service.

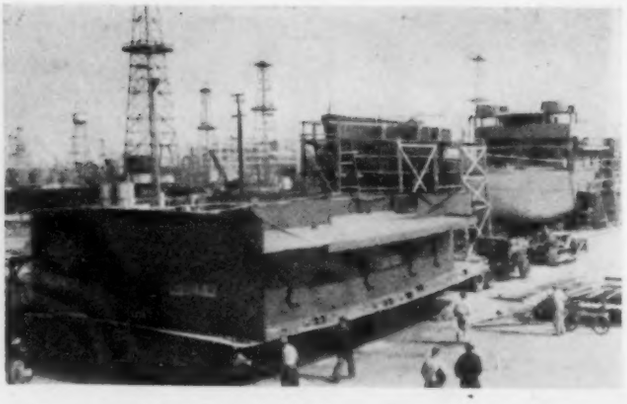


Fig. 3—A Prefabricated Deckhouse Arrives at the Shipyard

This deckhouse was prefabricated at the Baldwin Park plant of United Concrete Pipe Corp, 35 miles inland, and brought to the Long Beach shipyard. It is shown at the end of the "production line" where the ships are built in an "end to end" arrangement.

peller) is a built-up weldment of plates. These plates are flush welded which gives a perfect streamlined flow of water to the propeller.

The vessels are of the double bottom construction with a center vertical keel. The double bottom is divided into four separate tanks which, in turn, are subdivided by this vertical keel. This center keel because it is an oil-tight girder, gives eight fuel oil tanks. Four of these fuel oil tanks are under the machinery space and four are under the brine well space.

The hull of the vessel is divided into six subdivisions by a transome and transverse bulkheads which extend to the main deck. Moving from forward to aft, the first transverse bulkhead forms a subdivision wherein are located the forepeak tank, which is used for fresh water, followed by a deep fuel oil tank. These are separated from the machinery space by a water-tight bulkhead. Going aft from the machinery space or engine room, the subdivision holds the brine wells and shaft alley. In the last subdivision, formed by the aft bulkhead are located the afterpeak tank and the lazarette. In this subdivision there is an afterpeak tank which is used for fuel oil and two fresh-water tanks in the lazarette.

As pointed out above, the brine wells and shaft alley are aft of the machinery space. On each side of the shaft alley are located the wells which are secured in place by girders. There are girders top and bottom, fore and after of the alley and in addition to supporting the brine wells they give longitudinal strength. There are five brine wells on each side of the shaft alley, making a total of ten. These tanks extend from the shaft alley to the shell and between the double bottom and the deck.

The main deck of the tuna clipper is steel plate, flush welded. On this deck and forward of the forecastle bulkhead is located the upper machinery space, as well as the refrigerating compressors, cold storage rooms, machine shop and other store rooms. Aft of the forecastle bulkhead on the main deck are arranged the combination galley and mess room, partially enclosed well deck and bait tank. The bait tank enclosure is subdivided into three insulated bait tanks to carry frozen fish and condenser tank.

On the foreward part of the vessel and above the main deck is the raised deck. This deck is also steel plate, flush welded. An insulated steel deckhouse is located on the raised deck and has accommodations for sixteen of the crew. The roof of the deckhouse forms the bridge deck; however, in order to furnish insulation for the deckhouse, the steel plates of the bridge deck are over-

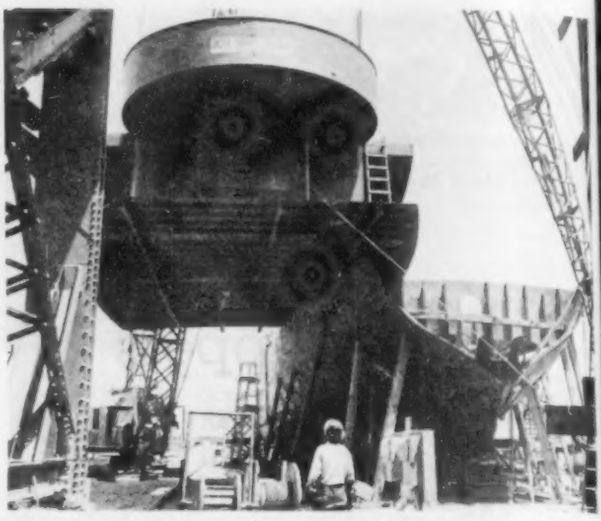


Fig. 4—After Arriving from the Prefabrication Plant at Baldwin Park, 35 Miles from the Waterfront, a Deckhouse Is Lifted Into Place in Preparation for Welding to the Hull

All plate work is done away from the harbor area where space is at a minimum and the ships sections such as deckhouses, keel sections, pilothouses, bulkheads, forepeaks are transported to the shipyard as they are needed and assembled as soon as they arrive.

laid with wood. Between this wood covering and the steel plate there is a 2 in. air space thus giving protection against the heat and the cold. The pilothouse, which is on the bridge deck, also has the same type of insulation in that there is a wood covering over the steel top with a 2 in. intervening air space.

Aft of the pilothouse on the bridge deck there is a raised steel fidley with hinged covers on each side of the stack. This allows ample light and air to reach the

Fig. 5—A View of the "Production Line"

Shown are seven U. S. Army vessels at various stages of construction. Upon completion a ship is moved from the building slab onto the marine railway and then taken to the launching carriage which lowers it into the water slowly and without risk of damage.

machinery space. The fidley top is bolted in place so that it and the streamlined stack may be removed when it is necessary to handleheavy weights to and from the machinery space.

The vessels have a single mast and one cargo boom and these are rigged in tuna boat style. For shore and work boats there are a large skiff, a small skiff and a 16-ft. power boat which are all stowed on the raised deck.

Engines

The propulsion is furnished by a six-cylinder direct reversible Diesel propelling engine which develops 840 hp. at 300 rpm.

There are two 200-hp. Atlas Diesel engines turning 500 rpm. and connected to Fairbanks Morse a.-c. generators. They develop 125 kw. (156 kva.).

Special Features

These new tuna clippers have a rakish profile and extremely beautiful lines. The vessel's form has unusually graceful lines with beautifully flared clipper bow and a cruiser stern. The stack is entirely streamlined.

One of the main features of the boat is the casing built above the raised deck which furnishes light and air to the machinery space even in heavy weather.

Also in these vessels, the machinery is set very low which obviates the necessity of an extremely wide boat, but at the same time giving ample positive GM— yet not too much so as to make it snappy. The vessel rolls steadily and rides easily—thus providing a good fishing platform. In regards to fishing the stern can be lowered until it is flush with the sea, but when the boat is under way the stern can be raised to a 24-in. free board even when the ship is fully loaded. The trimming of the vessel is accomplished by the transfer of fuel oil.

The designers and builders of the vessels have gone to considerable trouble and expense to insulate completely all necessary tanks and quarters. The crew's quarters are insulated throughout against heat, cold and sound. The sides and ends of their quarters have spun glass insulation with a plywood interior finish. The floors are wood over steel with a 2-in. intervening air space. Air holes are so arranged that there is a constant circulation in this space resulting in a cool and comfortable interior. An innovation in regards to crew's quarters is the extension of the bridge deck to the sides of the ship. This extension of the deck shades the sides of the deckhouse and gives protection both against the sun and from the rain, while at the same time it allows all possible circulation of air. All berths are equipped with individual fans.

Special attention was given to the problem of ventilation when these vessels were designed. There is a large forward cowl ventilator provided with an intake fan which supplies air to the lower part of the ship. Additional ventilation is secured by the use of two up-cast ventilators, with exhaust fans in each, which terminate in the fidley. These ventilators are run through larger vents from the galley and thus draw the heated air from the galley. The vents will change the air in the machinery space every five minutes.

The antenna for the radio system is run to a tripod on top of the pilothouse. This arrangement obviates the necessity of putting the foremast directly in front of the pilothouse which would obstruct clear vision, and gives a destroyer-like appearance to the clipper. The radio system is a combination commercial radio and radio telephone, and is rated at 500 watts.

Fig. 6—Looking Down the Slip of the Marine Railway at the Steel Ship Division of United Concrete Pipe Corp., a Vessel Can Be Seen in Position to Be Lifted from the Water for Repair Work

The railway can handle a ship 240 ft. in length and has a capacity of more than 1500 tons, and has the dual purpose of either launching vessels that have been built in the shipyard or of pulling them from the water for repairs.

There are no wooden tanks aboard the vessels, all being steel. Further, there are no dual-purpose tanks except six brine wells which are used for bait in addition to the regular bait tanks on deck. All the tanks throughout the ship are insulated with 6 in. of cork, 44,000 board feet of the material being used for this purpose.

Production of these modern tuna clippers is by methods which the United Concrete Pipe Corp. have used so successfully in the construction of ships for the U. S. Army. In the construction of Army ships, the company has prefabricated the ship's sections, such as deckhouses, keel sections, bulkheads, etc., at its Baldwin Park Plant, 35 miles from the nearest tideland. These prefabricated sections are transported to their Long Beach shipyard and assembled in what closely resembles a "production line." In regards to the tuna clippers, the vessels are prefabricated in six sections with the piping installed. These sections (three sections comprising the entire hull) are moved on huge trailers to the shipyard as they are needed and assembled as soon as they arrive. This procedure lends itself to economy in production. It also helps to relieve the critical manpower situation, found in any harbor area due to the necessary congestion, by having a major part of the work done a distance away from the waterfront.

When a ship is completed she is launched on the company's large marine railway. The launching of a ship on a marine railway is much different from the conventional method of sliding them down a launching way, for the railway lowers them into the water slowly and without risk of damage. By reversing the launching process on a marine railway, a ship can also be pulled from the water. This facilitates rapid repair work.

Safety Factors in Arc Welding

By R. F. Wyer*

THERE is one peculiarity which distinguishes the arc welding operator's job from other occupations. Arc welding is the only widely practiced industrial occupation in which the operator handles a live electric circuit all day. Yet, in spite of all the implications of that fact, the danger of electric shock to the operator is not as great as is often supposed. It is proposed here to discuss safety factors in arc welding from the electrical point of view.

There are, of course, other viewpoints. For example, the arc welding operation involves some fire hazards, as well as the ordinary mechanical hazards to the workman which are common to almost any industrial occupation. But these are not peculiar to arc welding.

The presence of fumes and smoke is likewise not peculiar to the arc welding process, and ordinary means of dilution and removal are employed. The medical aspects of this matter are the subject of careful investigations in a quantitative way, but they all point to adequate ventilation as the practical hazard-preventative measure.

Radiation of ultraviolet and infra-red wave lengths from the arc are sometimes regarded as serious hazards. They are not, in the sense that their effects can easily be prevented by commonly used protective helmets and clothing. Mystery rays are not present, although it is surprising how many times the rumor crops up that this or that arc welding equipment gives off radiations which result in sterility or peculiar ailments such as might be attributed to X-rays. Our own plant in Schenectady has effectively disposed of such rumors by having welding operators carry in their clothing pieces of photographic film for weeks at a time. None showed the slightest evidence of radiation.

Thus, the hazard of electric shock is the one of greatest interest from the arc welding point of view. It seems worth while to discuss it in considerable detail, because it is not as common a source of injury or death as might be supposed from casual acquaintance with the subject, and because there are definite ways in which even the small hazard can be almost completely overcome.

We have tried to keep records, and make a study of fatalities to welding operators from electric shock. It is a difficult task, because insurance statistics are not broken down quite far enough to reveal the needed data, also, rumors and newspaper publicity are notably inaccurate when dealing with deaths in the arc welding field.

For example, here are two versions, from different papers in the same city, of the one accident. "Stumbled and fell in such a manner that the electrode on his welding instrument was jammed in his mouth. The charged connection sent 550 volts through his body, killing him instantly." And, "Fell dead after 440 volts passed through his body. His heavy clothing, which all workers in the shop are required to wear for safety, was soaked with perspiration and, as he accidentally touched a highly charged arc rod used by another worker, a short circuit was caused and the power passed through his body." As a matter of fact, careful measurements immediately following the accident showed a maximum of 76 volts available to shock the victim.

But we do have some concrete information, and it shows a perhaps surprisingly small number of fatalities from this source. One insurance company[1] reported that among one group of policy holders, electric shock was the least frequent cause of occupational death classified—fewer deaths being attributed to shock than to falls, machinery, railroads or even drowning. This in spite of the fact that the group must have included electricians and workers in electrical manufacturing plants, and in spite of the often evidenced tendency to attribute death to electrocution in any doubtful case where a live electrical conductor is present at the scene.

In a survey which we made among four manufacturers using arc welding, selected at random and not including General Electric, these figures were obtained for the year 1941: There were a total of 14,475 industrial workers employed by the four manufacturers, with a total of 13 fatalities, or one death per 1110 workers. Included in these totals were 1125 arc welders, among whom there was one fatality.

Our own plants have for many years employed arc welders, with as many as 1500 welding operators employed at one time before the peak in this employment. Yet in the last seven years there has been but one fatal accident to a welding operator. This one was in 1938, and there is considerable doubt as to whether death was caused by electrocution or by a fall.

The district supervising engineer of one large insurance[2] company stated in 1942 that, as measured by compensation rates, arc welding is only 75% as hazardous as gas welding. Yet gas welding is not generally considered a very hazardous occupation.

In 1942, still another insurance company[3] reported

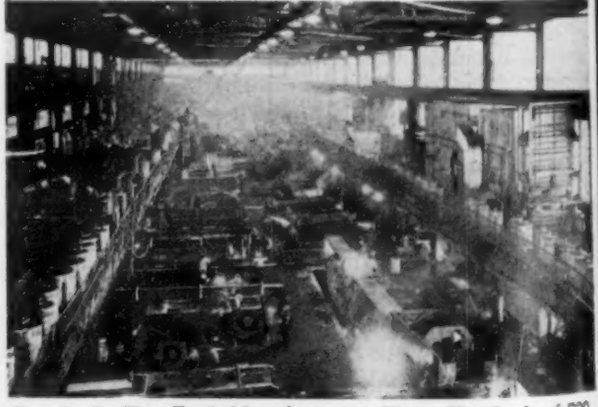


Fig. 1—In This Tank Manufacturing Plant, Hundreds of 500-Amp. a.-c. Arc Welders (on Balconies, Right and Left) Are in Operation

* Application Engineer, Electric Welding Division, General Electric Company.

Fig. 2—120-Ft. Bridge Girders for 15-Ton Mill-Type Crane Being Fabricated with Aid of Alternating-Current Arc Welders. Longest All-Welded Crane Girders Ever Built. Each Weighs 36 Tons

about one electrocution case per month for the preceding two years, only two of which involved arc welding. These two cases were the only ones they had had for many years.

While no figures on the total employment of arc welding operators are available, a conservative estimate based on industry sales of arc welding equipment and on the consumption of electrodes gives a figure well over 200,000 for the year 1943. So far, we have heard of only four electrocutions among arc welding operators during the entire year 1943.

The shock hazards which do exist might be classified as to their relationship to equipment and its layout, maintenance, supervision and operator education.

An idea of the magnitude of some arc welding operations, and of the care which must go into the selection and arrangement of the equipment, is shown in Fig. 1. This particular plant has about 250 a.-c. arc welders, which are shown on the balconies, left.

A typical application of arc welders is the fabrication of larger girders as shown in Fig. 2.

Figure 3 shows atomic hydrogen arc welding equipment in operation, and brings up the perpetual question as to the relative hazard in a.-c. and d.-c. welding. Here there is at times a potential of 300 volts between the two slender electrodes projecting up and to the left from the arc. It is alternating-current. No case of severe shock, and no fatalities resulting from the use of this equipment, have ever come to our attention.

The point is made to demonstrate the fallacy of arguments, based on clinical or laboratory experience, as to the difference between a. c. and d. c. with respect to shock hazards. In this equipment an adequately insulated electrode holder is used, and factory designed and built protective equipment disconnects the power when the arc is not actually in use.

Exhaustive studies on let-go currents, made at the University of California, definitely prove that under laboratory conditions, a victim is less likely to freeze onto an electrode with d. c. than with a. c., at a given current in milliamperes. But to draw the conclusion that d.-c. welding is invariably safer than a.-c. welding is to ignore the factors of voltage, insulation, protective equipment, skin resistance, and physical condition of the subject.

The extremes to which interpretations of these tests may go is indicated by the recent development of a theory, by a welding supervisor, that while 24 volts is safe, 28 volts is dangerous. Or by the performance of another welding supervisor, who knelt in water on a steel deck and grasped an electrode with soaking wet gloves, to demonstrate that one can feel 35 volts, but not 10 or 12. If such a demonstration ever convinces a welding operator that it is safe to place the body intentionally across any electrical circuit, it may well be a contributing factor to his untimely death.

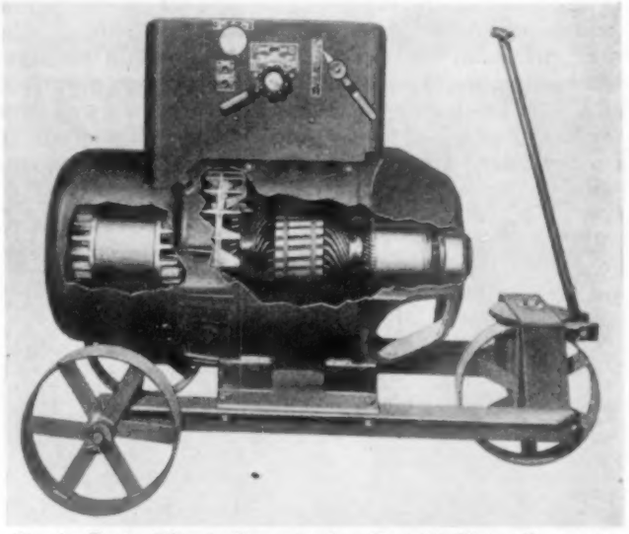


Fig. 4—Typical Single-Operator d.-c. Portable Motor-Generator Arc Welder, in Cutaway Section

Fig. 3—Atomic-Hydrogen Arc Welding on Aluminum

What are the welding equipments we are mainly concerned with? First, a single-operator d.-c. welder, shown in Fig. 4 is a cut-away view showing the motor at the left, with d.-c. generator at the right of the assembly. The motor usually operates on 220, 440 or occasionally 550 volts, three-phase, a. c. The generator delivers from 50 to 100 volts, d. c. Insulation around the windings of the motor, and additional insulation on the generator, effectively separates the power-circuit voltage and the welding circuit.

Shown in Fig. 5 is a common type of a.-c. welder which transforms energy from the power system into lower voltage and higher current, with control of the current output to suit it to the welding process. This equipment also insulates the power circuit from the welding circuit. The input, or power circuit winding, is electrically separated from the 75-volt welding circuit winding.

Another form of a.-c. welder is designed particularly for outdoor service. This welder includes a welding transformer like the indoor type, together with a built-in control panel which automatically reduces the voltage on the welding circuit to about 30 volts within one-fifteenth

of a second after the welding arc is extinguished, as when the electrode must be changed. Touching the electrode to the work automatically puts full power on the welding circuit again.

With respect to the installation of arc welding equipment, the major safety point is the necessity of grounding the frame of the welding set, regardless of whether it is an a.-c. or d.-c. unit, or whether it is stationary or portable. Common sense, as well as the National Electrical Code, demand that this should be done. An ungrounded unit, even one in perfect condition, can give annoying shocks and tickles to a grounded individual, because of the inherent ability of an electrical circuit to induce a static charge on another conductor separated from it by insulation. The effect is the same as that in a condenser, or Leyden jar.

In the event of failure of the insulation, due to age, abuse, or accident, the frame of a unit may become charged to full power circuit voltage, with serious consequences, unless the frame is grounded. If the proper ground connection is in place, however, the frame cannot have a voltage to ground, and the only effect of such a failure will be the blowing of fuses or tripping of circuit breakers and disconnection of the unit from the line.

This immediately suggests the necessity of installing adequate overcurrent protection and switches in the power circuit to the welder. Fuses or circuit breakers must be capable of interrupting the maximum current which may be drawn by a short circuit in the motor or power leads of a d.-c. welder, or in the primary circuit of an a.-c. welder. Disconnecting switches must be capable of interrupting the stalled rotor current of the d.-c. machine or the maximum current which can be drawn by the a.-c. unit when the welding electrode is short-circuited on the work.

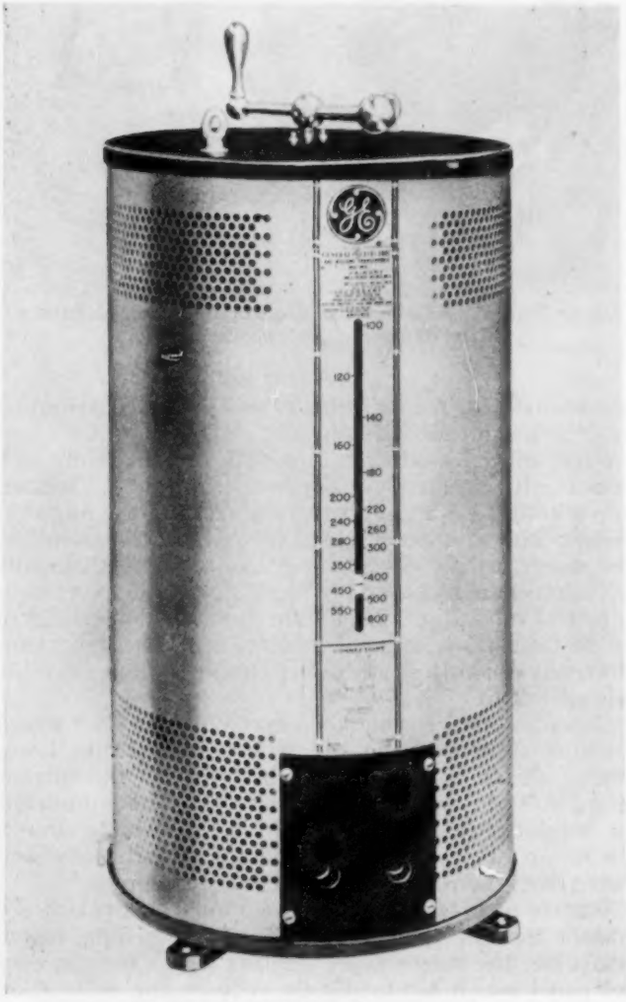


Fig. 5—Arc-Welding Transformer

Fig. 6—Tank for Large Oil Circuit Breaker Being Welded

On the welding-circuit side of a unit, care should be taken to avoid the possibility of getting double the normal circuit voltage between two adjacent welding circuits, because of the connection of one unit with one polarity, and the other with opposite polarity. On a.-c. units, abnormal voltage of somewhat lower value can also be obtained if adjacent welders are operated from different phases of the supply line. This factor has rarely, if ever, caused serious trouble because of the small likelihood that an operator will get hold of two welding circuits at once.

Probably the most important item in equipment, from the safety point of view, is the electrode holder. Although uninsulated holders have been used in arc welding for many years, good practice unquestionably requires that fully insulated holders should be used.

Figure 6 not only shows an uninsulated electrode holder but incidentally, an ideal set-up for potential trouble. The operator is in a cramped space, and also undoubtedly in contact with the conducting metal in a number of places on his body, unless his clothing is dry and his shoes free from nails. In his hand he holds an electrode holder which has a handle of insulating material, but through which extends an uninsulated screw-head. Probably any contact he might make with the screw, through wet gloves or with the bare hand, would be too small in area to permit electrocution. But a shock may make him do something involuntarily, which will put him in danger. The worst feature of this holder is that the head, projecting out beyond the ring or collar of insulating material just above the hand, is entirely uninsulated. Each time the operator changes welding electrodes, there is a good chance that he will contact this exposed metal. If he should fall on the holder, or sling the cable over his shoulder or around his neck, as is frequently done, this live conductor may contact his chest or back. (Fig. 7.)

There are now several types of good insulated electrode holders on the market. They should be used on any welding job, and their insulation should be kept in first-class condition. Studies of accident reports reveal, in a

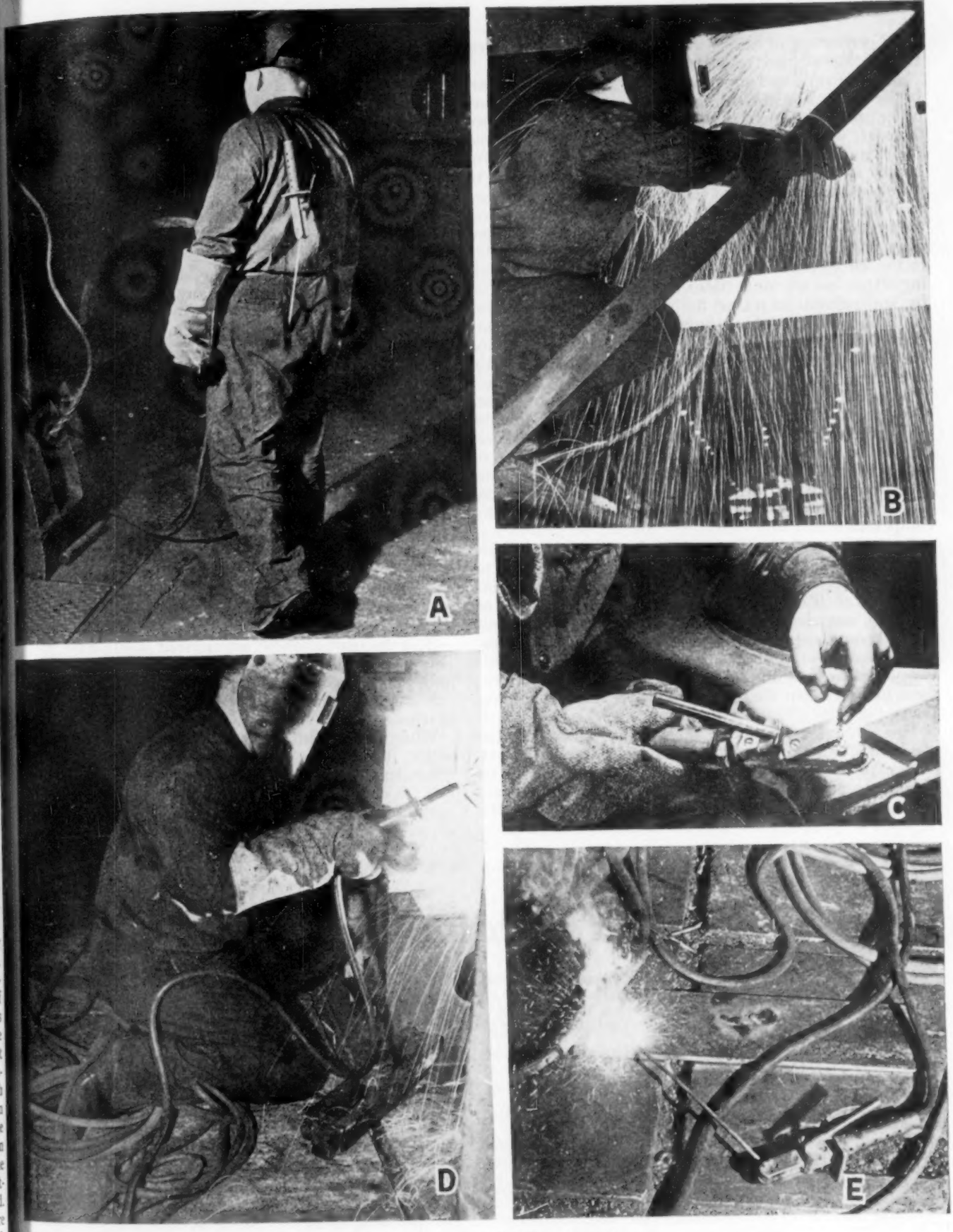


Fig. 7—Dangerous Welding Practices

A—Operator should never sling an electrode holder over his shoulder, nor leave an electrode in a holder not in use.

B—Operator should be particularly careful when working above the floor or ground, since many fatalities are caused by falling.

C—The insulation of this electrode holder is broken.

D—Cables coiled under operator's feet and legs may trip him when he rises from squatted position.

E—Electrode holder should never be thrown or placed where it can make contact with conducting material.

good percentage of cases, evidence that uninsulated electrode holders caused or contributed to death.

Maintenance and supervision play an important part in the safety side of welding, as is the case in almost any other process. Fire hazards should obviously be watched for and, when found, eliminated. Welding cables and their connectors should be examined frequently for breaks in insulation. The extremely hard service to which welding cables are subjected often results in severe damage to the insulation. Yet the welding operator, accustomed to arcs and sparks in his daily work, often disregards accidental short circuits which spell trouble to the safety man or the fire inspector. Likewise, welding return circuit connections should be given attention, by supervision. Arcs or flashes in unexpected places along the return path of the welding current may result in fire hazards if reinforcing rods, scrap lengths of pipe or bar laid together, or building piping are indiscriminately used.

The maintenance of adequate safety ground connections to the frames of all welding machines should be checked, because many operators do not realize their importance. For the same reason, the maintenance of insulation on electrode holders should not be left to operators alone. Electrical repairs and connections on the power-line side of the welder should be handled only by competent men.

In the last analysis, it is obvious that the welding operator and his safety education plays the greatest part in preventing accidents to himself. It is undoubtedly significant that at least one—there are probably others— of the large electrical manufacturing concerns has an unusually good accident record in regard to shocks to welders. Regardless of special instructions, the whole philosophy of such a group of workers leads to a healthy respect for all electrical circuits and proper care in handling them.

The paramount warning should be to take particular care in hot and humid weather, and when welding in wet places. Almost without exception, fatal accidents to welders occur in hot weather. The operator's own condition and that of his clothing should be his guide. He should always guard against wet gloves, shoes, and clothing, particularly clothing made of thin cotton fabrics.

The operator should assume the major responsibility for seeing that the insulation of the electrode holder is in good condition.

He should learn to carry an electrode holder by the handle, never slung over his shoulder, or squeezed under his arm,

He should never, under any circumstances, transport an electrode holder with an electrode or electrode stub in it.

He should never throw or lay an electrode holder down so that it makes contact with any conducting material.

He should never work alone in confined or concealed spaces where, for example, striking his head may cause temporary loss of his faculties.

He should be particularly careful when working above the ground or floor, since it is significant that many fatalities involve a fall.

Case studies, incomplete as they usually are, give a basis for these recommendations. For example, in all but one of nine reports of accidents, dating from 1934 to 1943, the statement was made that the weather was very hot, or that the victim's clothing was soaking wet. In five of these nine cases, a fall was involved, ranging from a height of eleven feet to the case of a standing man who fell to a steel floor. In every one of them, the electrode holder was uninsulated, and in none was there evidence of contact with any live part other than the electrode holder. Four of the cases involved arc welding operators working in confined spaces.

This discussion can be summarized as follows:

1. Arc welding is not a hazardous occupation, as judged by industrial standards.
2. Electric shock is a relatively infrequent cause of death.

Where electrocution of the welding operator has occurred, one or more of three factors was usually involved:

1. An uninsulated electrode holder.
2. Wet gloves and clothing.
3. A fall.

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(*Continued on page 153*)

Aluminum Spot Welding Tips

By Eugene J. Peltier*

AN EXCELLENT outline on "How to Spot Weld Aluminum" is given in the August 1942 issue of THE WELDING JOURNAL, which is the Journal of the AMERICAN WELDING SOCIETY.

This information may be purchased separately in a reprint issued by the SOCIETY. It is called "Tentative Standards and Recommended Practices and Procedures for Spot Welding of Aluminum Alloys." The price is one dollar.

This article fully explains the processes required for successful spot welding of aluminum. A careful study of these Standards, combined with a knowledge of the theory of electricity, will enable anybody to efficiency supervise, inspect or operate an aluminum spot-welding department.

There are several points in aluminum spot welding, however, which need special analysis from time to time and in this paper I shall attempt to outline some of them.

Prior to the war and the tremendous increase in the aircraft industry, aluminum spot welding was a specialty confined to a few manufacturers such as those making household utensils and special electrical apparatus.

However, the spot welding of ferrous metals, brasses, stainless steel, etc., was quite widely utilized in industry. Expanding requirements for fabricated parts of aluminum necessitated the revamping of existing equipment in order that it may be utilized.

Aluminum spot welding requires higher current values and a much closer control of the duration of the weld than that needed for most other metals.

Fortunately, electronic timers had been developed and perfected to such an extent that the exact type needed may be purchased, with proper priorities, and connected to present resistance welders.

These electronic timers allow a very accurate selection of timing the duration of the weld from 1 cycle to 30 cycles. That is, with a 60-cycle alternating current supply, the time can be accurately controlled within the range of from one-sixtieth of a second in sixtieths of a second up to one-half second or more.

This is a tremendous advantage to machines on which the duration of the weld is controlled by a can on the driving mechanism or some attachment operated by air-pressure switches or similar devices. With an electronic timer the duration of the weld can be accurately set merely by adjusting a dial, whereas a mechanical control requires considerable work and only approximate results are obtained, never approaching the accuracy of the electronic timer.

Unless a welder is already equipped with condenser discharge apparatus, or is of the stored inductive energy type, it is advisable to add an electronic timer.

A second point in the adaptation of present equipment is the analysis of the current capacity of the machine. Since aluminum has a relatively high conductivity, a much higher current value is required to spot weld it as compared to ferrous metals. Currents ranging up to 50,000 amp. are needed to obtain the proper size of spot weld when working with heavy stock such as quarter inch welded to quarter inch. Some setups are such that cause high secondary impedance requiring high machine capacity to overcome this impedance and provide sufficient current for the weld.

The duration of the weld for aluminum is considerably shorter, in general, than that for ferrous metals, and in most cases the loading of fixtures and directing the parts between the points require considerable time as compared with the actual welding time. This leads toward a low-duty cycle; that is, the ratio between the current time on and the current time off is quite low. Most spot-welding transformers are designed for a 50% duty cycle, indicating the current time on is equal to the current time off. The controlling factor in the design of these transformers is the dissipation of heat. With a low-duty cycle, such as is common in aluminum spot welding, these transformers could stand more load without overheating.

The current capacity of most machines can be increased, in some cases up to 25%. The following procedure is used to increase the output of these machines.

The transformer is disconnected from the line and a test is run on it to plot its saturation curve. This is done by leaving the secondary windings open and impressing a potential on the primary, ranging from 50% of the normal primary voltage to a point at which the exciting current increases rapidly with a small increase in voltage. Readings of impressed voltage and exciting current are taken at small voltage steps. From these data a curve is plotted using the voltage as the abscissa and the current in amperes as the ordinate. The point on this curve at which the current starts to increase rapidly with a slight increase in voltage is called the knee of the saturation curve. The voltage value just below this knee is the value at which the transformer can be safely operated. In most cases this value is higher than the rated primary voltage of the welder. Thus, with a suitable transformer, auto transformers, or induction voltage regulator, the voltage impressed on the primary of the welding transformer can be increased with a corresponding higher secondary current.

When the installation includes an electronic timer and the primary connections to the welding transformer are made through electronic tubes rather than contactors, there is a definite voltage drop across these tubes. This drop causes a reduced voltage to be impressed on the primary windings of the welding transformer.

The exact amount of this drop can be determined by examining the manufacturer's characteristics of these tubes.

The line voltage can be further increased by the amount of the voltage drop of one of these tubes.

This increase in capacity puts an added load on the power lines feeding the equipment as well as the fusing of the power circuit. These points should be checked, and if several spot welders are on the same power lines it is

* Foreman, Westinghouse Elec. & Mfg. Co., Springfield, Mass.

advisable to locate welders as close as possible to the main power busses or substation.

The effect of simultaneous operation of two or more welders on the power supply, and on the quality of the weld produced on the individual machines, is adequately described by another article in THE WELDING JOURNAL. It would be well to state that the effect of this simultaneous operation is proportionate to the voltage drop in the supply lines indicating again that adequate supply lines and locating your welding department as close as possible to the feeder transformers are vital details to consistancy in spot welding.

Even after reconnecting your spot welders in such a manner to obtain the maximum current from them, you may occasionally be asked to weld some parts requiring more current than is available. In stating the amount of current required, I refer to the tables of current values, pressures and time of duration as advised in the "Tentative Standards and Recommended Practices and Procedures for Spot Welding of Aluminum Alloys." These values are for obtaining an ideal weld, but a certain amount of latitude is allowed if one understands the effects of deviating from the values given in the tables.

Let us take a look at the formula

$$H = I^2 \times r \times t \times k$$

in which

H = the heat in watt seconds
I = the current in amperes
r = the resistance between sheets in ohms
t = the time in seconds of the duration of the weld
k = a constant controlled by the dissipation of heat in the weld area.

An analysis of this formula shows that any of the factors on the right-hand side of the equation could cause a change in the heat obtained. Now if the required current I is not available, a sufficient increase in r or t would compensate for the lack of current. r, the resistance between sheets, can be increased by decreasing the pressure applied on the work. t can be increased by lengthening the duration of the weld. The quality of these welds may not be absolutely ideal, but by properly adjusting values of pressure and time a very satisfactory weld may be obtained from a machine slightly under the current capacity desired.

Thus far we have discussed the application of equipment formerly used for spot welding steel to the duties of spot welding aluminum. In several cases, new equipment is purchased. Concerns manufacturing this equipment will, upon request, advise the specific type best suited for your application. It is advisable to be sure of accurate timing control plus sufficient current capacity for the heaviest sections you will be required to weld. Purchase a machine or machines which will not overtax your available power lines, because new power wiring and transformers are costly and difficult to obtain.

The Tentative Specifications for Spot Welding Aluminum recommend the use of analytical cross sections of sample pieces to determine the quality of the weld when setting up the machine. They advise setting the current, time, pressures, point size and contour before starting to weld. Then weld two test pieces together. These test pieces are cut across the weld, taking care to leave over half of the weld on the part to be analyzed. This part is filed using a "Vexon" or milled tooth file until the weld is sectioned exactly in the center. The Standards advise the use of "Keller's Etch" to etch the sample, but a hot concentrated solution of Oakite No. 30 or caustic soda followed by a clear hot water rinse, then a dip in 25% nitric acid and another clear hot water rinse does a satisfactory job. After the section is etched, the weld nugget is clearly defined and can be readily analyzed. The ma chine setup or point contour may be altered and the se tioning procedure continued with more test pieces unt an ideal section is obtained.

Once this ideal setup is obtained, the operator mus use special care not to alter it in any way without chec ing the new setup with another section analysis.

The operator must prevent the welding points fro shorting against other members of the assembly to b welded, otherwise some of the current will be diverte from the weld area and an inferior weld obtained.

Fixtures should never be made of steel because th presence of steel in the secondary enclosure will increas the impedance of the secondary circuit thereby reducin the current and affecting the weld. Also the high surg of current will pull any ferrous fixture and is likely t thurst the assembly out of correct location or surprise th operator.

By far the most critical factor and the hardest t control is maintenance of the spot-welding tips. Th contour of the surface of these tips which contact th metal to be welded control the penetration of the wel into the respective pieces, as well as the size of the weld Since the tips will pick up aluminum after a certain num ber of welds, they must be periodically cleaned. Thi cleaning must not alter the contour of the tips and mus be done with extreme care by an experienced operato otherwise the character of the weld will be changed an in some cases will cause a complete loss of weld. Care ful, thorough instruction to each operator and a periodic checkup by section analysis is the only way to contro consistency throughout a large number of welds. The original setup cross section should show sufficient pene tration, about 40%, into each of the two pieces and should be of sufficient size. That is, the diameter of the weld should be equal to twice the thickness of the thin nest piece plus one-sixteenth of an inch. This will allow for slight variation in point contour and size that even the expert operator cannot avoid.

It has been proved that a well-trained operator starting off with a good section analysis and carefully dressing his points can make several thousand welds in aluminum with an extremely low percentage of defective welds.

A periodic test piece set up in a tensile testing machine is advisable to assure proper strength of weld.

In analyzing a cross section of a spot weld, clearly de fined areas show concentrated heat between the two sheets welded. This is desired. Cloudy areas show poor concentration of heat and cloudy areas extending toward or up to the point of tip contact indicate heating of the sheets on the surface. This will lead to poor surface ap pearance and rapid tip deterioration as well as exces sive aluminum pickup on the tips. Recommended cor rection for this condition is a larger tip area and more thorough tip cleaning. A dirty tip will cause more heat at the point of tip contact on the sheet. This is due to the fact that the contact resistance between an aluminum coated tip and the sheet aluminum is greater than that of clean Cupuloy and aluminum. Surface spit or indica tions of aluminum melting on the surface is unnecessary and indicate a very poor machine setup.

Another detail to simplify spot welding aluminum is to use high current values, low time values and high tip pressure. These values are so recommended in the Tenta tive Standards, and by adhering to them a greater num ber of good welds can be obtained between tip cleanings, thereby increasing tip life and reducing labor costs.

In setting up a spot welder when previous data have not been collected, it is good practice to select tips whose contact area is proportionate to the thickness of the sheet to which they will contact. For example, when welding a

1/8-in. thick sheet to a 1/16-in. thick sheet, the tip contacting the thicker sheet should have approximately twice the contact area as the tip contacting the thinner sheet. This tends to focus the current so the greater concentration will be between the two sheets where it is required.

Careful maintenance of all equipment will reduce breakdown time, departmental overhead and help meet production schedules. All machines and auxiliaries are generally supplied with instruction manuals and if they are not on hand, the machine suppliers will provide them. These manuals should be carefully studied by whoever is responsible for the maintenance of the machines. Also each individual operator should know enough about his machine to avoid calling in assistance to make some adjustment for which he himself is responsible. This statement should not be misconstrued to indicate that the operator should tamper with the electrical circuits, tubes, relays or protective devices, but he should be certain that cooling water circuit is functioning, his setup is correct and the electronic timer has come up to heat.

Generally, if there is any current at all at the tips of the machine and a good weld is not obtained, the settings of time, current, pressure and tip contour are incorrect rather than something being radically wrong with the apparatus. An exception to this is that one of the ignitron tubes in the electronic timer may be irratic or inoperative allowing only one-half of the wave to pass. The tube life is long, but when a machine is making from 3000 to 15,000 welds in an 8-hr. period these parts are subject to wear after long use. A list of all parts which are subject to failure should be made and ample replacements kept on hand. This investment will pay for itself many times in reduced breakdown time and production schedule made. A good supply of welding tips, electrode arms and holders of various types to make special setups is a valuable stock to have on hand.

In conclusion, if you are ever called upon to do any aluminum spot welding, I would suggest that you obtain a copy of the "Tentative Standards and Recommended Practices and Procedures for Spot Welding of Aluminum Spot Welding Tips from the SOCIETY, and it will greatly assist you in any problems.

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Save Those Tires

By L. J. Rumig*

AN AUTOMOTIVE service company has built up a good business by altering automobile disk wheels with a cutting blowpipe. The wheels are then able to take wider rims, and thus help save tires.

Authorities have found that it is of great importance to mount the tires on the right-sized rim. It has been proved definitely that the rim width directly affects the rate of tire wear, and therefore can become a contributing factor to tire life. The larger-sized tires that have become popular in recent years do not always give users the absolute maximum mileage, since such tires are frequently mounted on rims designed for the smaller tires of earlier days. Rim width was a matter of no great concern when rubber was plentiful, but now it is of decided importance. It is understood that when the manufacture of wheels is resumed, they will be made with wider rims.

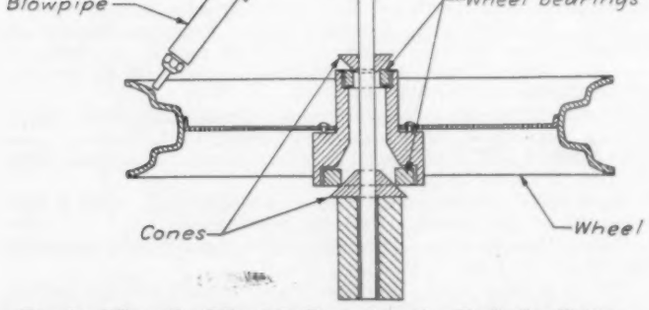

Fig. 1—When the Wheel Is Turned on the Shaft, the Cutting Blowpipe Will Remove the Bead of the Old Rim Neatly and Accurately

When a large tire is mounted on a narrow rim, the tread surface is curved sharply, leaving only the center in contact with the road; this results in concentrated, rapid wear. The side walls are belled out and are more easily damaged. If the same tire is mounted on a wide rim, the tread tends to be flattened out and to make full contact with the road, resulting in uniform wear and better traction; the side walls remain in normal position and are better protected by the sides of the rim.

This automotive service shop makes a specialty of replacing rims on light delivery trucks. At first the old rims were removed from the steel disk wheels by cutting them off in a lathe, but this soon proved too slow and too expensive. It was found that the same, or better, results could be obtained with an oxyacetylene cutting blowpipe in a fraction of the time and at nominal cost.

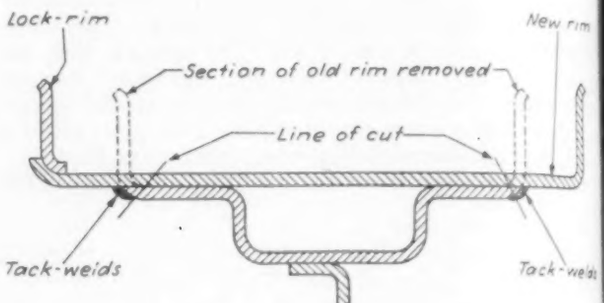

Fig. 2—The New Rim Is Mounted on the Remaining Portion of the Old One and Attached by Tack Welds at Five or Six Points on Each Side

Method of Procedure

In this shop the cut is made by mounting the wheel and the blowpipe in an old rig that had been used years ago when truck wheels were converted from solid to pneumatic tires. A suitable rig can easily be fabricated with a welding blowpipe from scrap material that can be found in any service garage. The sketch, Fig. 1, indicates the arrangement.

The wheel rides horizontally on a vertical shaft—a length of scrap pipe would serve the purpose. The two cones, the upper one of which is adjustable vertically, permit the accommodation of wheels of various hub sizes. The blowpipe is mounted on a bracket on the shaft, above the wheel. Either a hand- or a machine-cutting blowpipe may be used. By merely turning the wheel at the proper speed, with the blowpipe remaining stationary, the bead of the rim can be cut off accurately and neatly.

After both beads of the old rim have been cut off, the new wider rim is mounted as shown in Fig. 2 and attached to the remaining portion of the old rim by tack welds at five or six points on each side. No attempt is made to balance the wheel until after the tire is mounted. Before welding, however, the rim is properly centered with respect to the wheel and a check for trueness is made.

It will be noted from the sketch that the drop-center type of tire mounting used before the alteration is eliminated and the new rim is equipped with a lock-ring. This is merely for convenience in forming the new rim and attaching it to the remains of the old one.

* The Linde Air Products Co.

Welding versus Riveting on Hopper Dredge Construction*

By S. E. Lawrence†

WAR emergencies and the necessity for utilizing to the fullest extent all our industrial resources have resulted in many new combinations of efforts and usages of all the facilities as they exist in our machine world.

The will to do and to get results with the means at hand has given birth to an expression among river and harbor men familiar with the determination and ingenuity of men who operate dredges. This wordage bids fair to come into the language in time as an expression of accomplishment of difficult tasks with the immediate means they control—this idea is summed up in the cryptic phrase "dredge boating." If you hear a man say "that's dredge boating" you may know some one is doing a lot with little, or getting full benefit out of what he has at his command.

About a year ago it became imperative to construct some small (in point of yardage), shallow draft seagoing hopper dredges, (Fig. 1). They were designed by the Marine Department of the U. S. Engineers, under the direction of Colonel H. B. Vaughan, Jr. (now General) Corps of Engineers, for quick production to help out in our shallow or medium depth waterways or those of our allies.

Their design followed the general principles for dredges of this type which have been developed by the U. S. Engineer Department, but brought these basic ideas up to date in accordance with best proved practices. Ordinary building conditions would have made the construction of these two dredges a real pleasure and a proper monument to two former members of the Corps of Engineers. They are named the *Hains* and the *Hoffman* after two deceased members of the Corps of Engineers—as is a custom of the service.

When proposals for building these two 300–700-cu. yd. dredges were being considered, it was found that most of the shipyards ordinarily available for such work were not only already overloaded, but each yard was developing its own facilities to produce maximum effort and results in shipbuilding—and a seagoing dredge is a ship as well as a dredge.

One company had gone all-out for the welding of hull plating, scantlings and everything else. Another was at that time set up for riveting—from the drafting room through the hold loft, laying out, fabricating, fitting up, riveting, etc. Not only shops and tools adapted to riveting, but their mainstay of men were riveters, heaters, passers and buckers up. They were a riveting outfit throughout.

Other yards, seeing the handwriting of competition on the wall, were in a state of transition. Their plant had a background and a big investment in riveting equipment and riveting personnel, but their new force and equipment were being built around the more modern methods made possible by the welding process and the ease with which welders can be more quickly trained.

It costs money to change over and not only money but time, which we did not and do not have. Common sense demanded that the yards do with what they had supplemented by what they could acquire most expeditiously.

* From a paper submitted by S. E. Lawrence, Chief Marine Branch, U. S. Engineers Dept., Philadelphia, Pa., in the Industrial Progress Award Program sponsored by The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio.

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Fig. 1—First Seagoing Hopper Dredge of Partially Welded Design

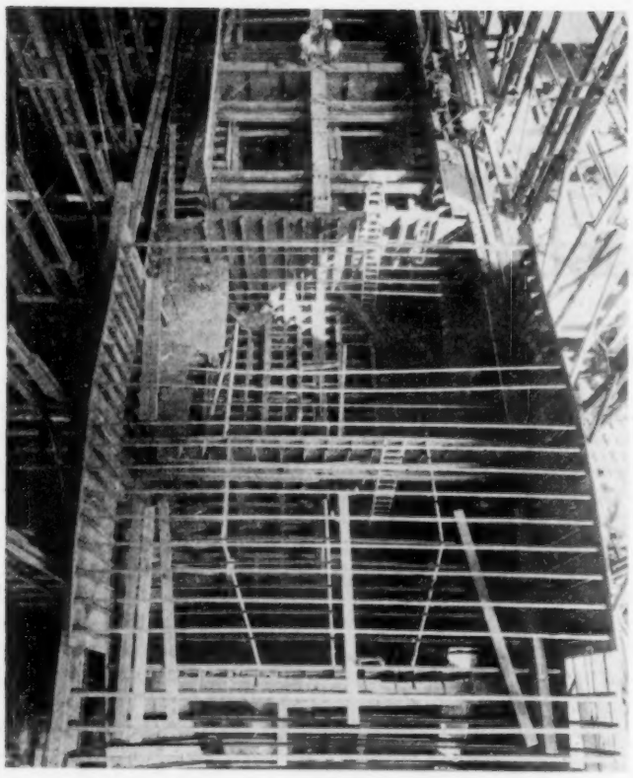

Fig. 2—Dredge in Early Stages of Construction

Therefore, an agreement was made with a yard which, while fundamentally a riveting yard in years gone by, was equipped throughout for riveting down through and including the personnel—foreman and men of trained skills. This yard was also facing a conversion to an approved step ahead in their building methods. They were equipped in a lesser degree as a welding yard, too.

Engineers realized that the maximum efforts must be made in the production of these dredges by combining the efforts of both classes of production and methods of construction. The construction agreement was made so that all available facilities could be brought to bear on this essential war problem. The bow and stern of these dredges, speaking generally, were to be riveted and the amidship sections of the hulls were to be welded (Fig. 2).

During their building the past few years have seen many interesting combinations of these two schools of fastenings of hull and structural shapes, either of which would have produced a dredge and both combined have made it possible to call into action much needed war tools by utilizing a mixture of both in a yard which could not have brought its full force to bear by using welding or riveting alone.

It is difficult to evaluate the two methods of this work, because of the stress of the times and distorted condition of procurement, delays making sequences of operation difficult, and the intermingling of portions of the work, and also because there are few comparable jobs that are riveted one time and welded another.

Certain things have been gleaned from this experience, however, and it has served as a laboratory for future reference even if the experiments were not conducted under the most favorable times and conditions.

1. The first lesson that was emphasized was the desirability of proper design for either welding or riveting in work of this type.

2. The great field for savings to be effected in a plant in transition by following through from design to finished product. It is not merely the substitution of a new fastening to obtain an equivalent strength. Many savings can be effected. Savings of weights of metal, economy of shapes, easier fabrication of sheets, simplification of fittings—dead weight saving of welding rods over rivets, etc.

3. Savings of time were found harder to equate, due in part to the fact that facilities were not previously provided to expedite welding operations and due to lack of time to work out the simplest, most economical manner of welding a seam, i.e., whether overhead, down welding, side welding, etc.

4. Units of price work costs were difficult to reduce to a common denominator for comparison. Labor prices, for mechanics of certain classes did not reflect their day rate in consistent constancy. This can only be fairly compared where, say, tanks of the same size are constructed with setups under favorable working conditions for welding in one case and riveting in the other. The continually varying jobs on dredge building were not conducive to accuracy.

Comparisons could not be made to an extent that would fairly reflect in a comparable manner the most desirable method, except in a few instances. An attempt to set forth such isolated comparisons would entail too many explanations of the facilities or lack of them in the plant in which this work was done.

Very definitely, however, welding proved a ready supplement to an inadequate supply of riveters and in an emergency where the immediate need would not permit the lengthening out of the building period to conform to the number of accessible riveting personnel. The two methods of welding and riveting were carried on without conflict or embarrassment to the work.

Special precautions were taken in assembling the plates and parts, especially in curved hull sheets to prevent undue contraction of the joints which would result in buckling and warping of frames and stiffeners (Fig. 3).

Since the bow and stern were riveted, only the simplest straightaway sections were involved in these welding precautions. While not especially designed originally for welding, this point was considered in the making of construction or shop drawings and by a selected sequence in welding and in some instances by prespringing of sheets, etc.

Of course, it is too soon to determine whether any

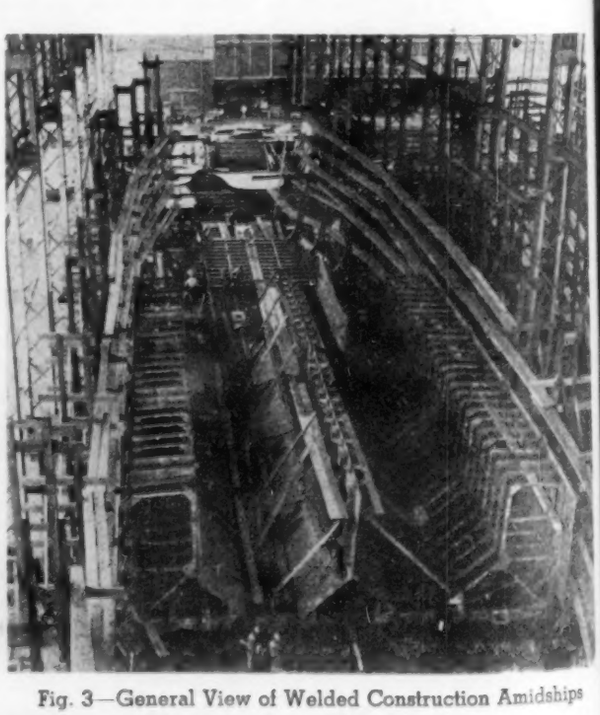

Fig. 3—General View of Welded Construction Amidships

internal stresses of a serious nature have been set up in the hull, but none were evidenced after launching and since many authorities agree that these stresses tend to be largely relieved of themselves after a time, none are anticipated to develop. As is customary, certain sections were preassembled in convenient places and welded before erection, such as machinery foundations, bulkheads in part, etc.

Ordinarily it is the practice on a ship for welding to start at approximately the center of the vessel, with the welding progressing outward, forward and aft from that point. In the instance of the *Hains* and *Hoffman*, it was a somewhat modified case. After the midships sections had been constructed in this customary manner these sections then had to be fasted by welding to the riveted bow and stern sections, and allowances had to be made accordingly.

Weight savings in the welded portions were estimated to be close to 10% and can be translated into extra cargo tonnage in a freight carrier or in increased carrying capacity in the case of a dredge—cubic yards of mud.

Savings of weight was one of the advantages of our combination system of construction. In the welded section this was augmented by doing away with plate laps and straps, faying flanges of frames, etc., stiffeners, connecting angles, clips, etc. Another advantage we counted in the welded section over that of the riveted sections was: strength—no weakening of frames from rivet holes, even though intangible unrelieved residual stresses may have tended to offset this somewhat. With good metal and workmanship, little question remained about the strength of a joint, very good ductile weld metal was used.

Much might be said of the stresses and strains produced in plates and structural members when no means of relieving them are attempted, or where "free" ends cannot be conveniently left or peening done.

Of course some buckling of plates was expected with the corresponding warping of stiffeners but little if any of that was in evidence.

In making a comparison of welding and riveting on work of this nature the most difficult part of the equation is the relative labor cost.

The following points go into the establishing of rates in welding, with labor only involved and a crew consisting of one welder only.

1. Size of welding rod (usually up to and including $^{7}/_{32}$ in. in diameter).
2. Kind of current (whether a. c. or d. c.).
3. Kind of weld (fillet or butt, one or two sides).
4. Thickness of plates or shapes.
5. Position (whether flat, vertical, horizontal or overhead).
6. Location (ship board or slab).

It is easy to see how many combinations are required to make up a wage scale for work of this character, especially when your plate thickness may vary all the way from $^{1}/_{8}$ to $1^{1}/_{8}$ in. and again when special work other than simply joining plates or shapes are involved.

When riveting rates for labor were set up for piece work (price per hundred rivets) both snap and flush riveting had to be considered. The following point then had to be taken into consideration.

1. Size of rivets ($^{3}/_{8}$ to 1 in. in diameter, and sometimes length was taken into consideration).
2. Whether work was on ship or ground work.
3. Number of rows (single or double).
4. Location aboard dredge: The location greatly determined the piece difference in the cost for labor. Several locations were considered comparable and the same price per hundred for the location of rivets was set

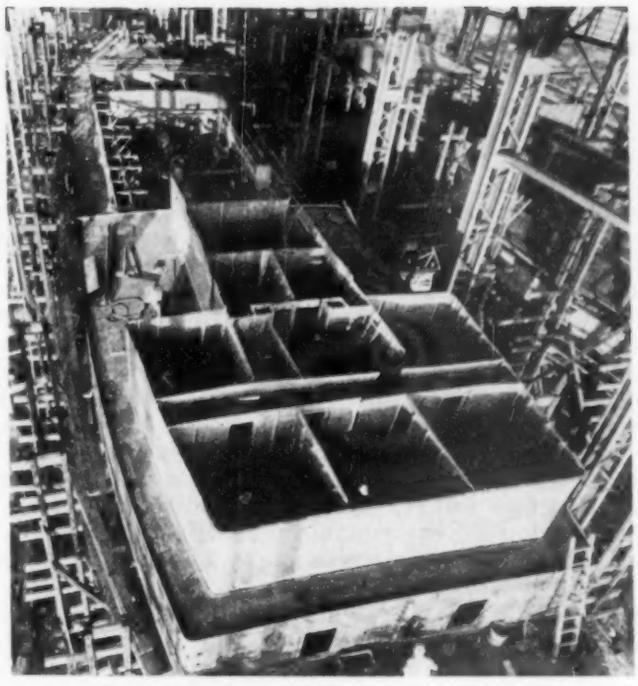

Fig. 4—Dredge Showing Advanced Stage of Fabrication

i.e., $^{1}/_{2}$-in. snap riveting for deck house bulkhead, lower deck, "promenade" deck (Fig. 4) were all considered as of equal value. Prices varied on an ascending scale for the following $^{3}/_{4}$-in. riveting. The first seven items listed below were given the same rate. Those following increased somewhat with each item: (1) deck house inside; (2) side stringers; (3) keelson; (4) frame connections; (5) beam keel brackets; (6) framing in hold; (7) rider plate; (8) intercostals; (9) engine girders; (10) C. V. keel; (11) frame brackets; (12) steering engine foundations; (13) trunks and vents from ladder.

Some 77 different similar locations were set up for snap rivets alone, in sizes ranging from $^{3}/_{8}$ to $^{7}/_{8}$ in. Thirty-seven of these locations were ship work locations, and the remaining forty were classed under ground work, varying all the way from comparatively light smokestack fabrication ($^{3}/_{8}$ in.) as the low on the scale (approximately $2.40 per hundred) to "trunk and vents from ladder" as high as approximately $7.50 per hundred rivets.

In the flush riveting piece work involving $^{3}/_{8}$ to 1-in. rivets the same distinction is made as to which is ground work, and over a hundred different locations and conditions were enumerated (56 of them are in ship work and 46 are ground work).

Some of this work ranged as high as $12.30 per hundred on special locations and on large 1-in. rivets. These unit costs included all labor connected with driving the rivets. These unit costs included all labor connected with driving the rivets of this size in special locations and under the specific conditions set forth.

An enumeration of these different locations in themselves would serve no purpose here. It does, however, give an idea of the great number of classifications required in setting up a riveting labor price schedule for piece work.

Granting that the unusual conditions under which these dredges were built were so fraught with factors not found in a more consistent time and granting the distortion of some of the ordinary controlled features of such construction still certain conclusions are obvious from this experience.

The day of riveted hulls is passing as surely as the trade of the blacksmith or the hour of the old broad ax

man who hewed the timbers of the early American sailing ships, for the same reason that all good practice eventually yields to better especially in this country where ingenuity is more quickly capitalized than anywhere else in this mechanized world.

It is only a short time since the first all-welded hull of a seagoing ship was produced and reams were written of it. Years of performance may not be behind such a hull but certainly sufficient concrete evidence is at hand to convince some of the old riveters themselves. The desirability of welding forces itself upon you as the accepted ultimate in this class of construction and is conceded from the limited comparative observations made in the production of the *Hains* and *Hoffman*.

One of the chief lessons learned is that, in the period of transition from riveting to welding these two brothers of the art of hull building can go hand in hand for a time but as the newer methods of welding are adopted and adapted there will come a natural parting of the ways. Both are doing their part under stress of war production, and either could do the job in time—and about the same time at that due to war restrictions.

It is not, in the opinion of this observer, advisable to make a practice of mixing these two methods except where necessity dictates, even though in this case it justified itself. Decisions of combinations of effort must be made at times like these in each separate case and results obtained with what is at hand.

When events so shape themselves and choice can be made the episode of the *Hains* and *Hoffman* will point ahead definitely to welding starting as an accepted and approved method at the design board with that in mind, and following through step by step to the digging of the first load—and further for maintenance is simplified in many, many ways because of welding design and construction.

Our vote is for a completely welded job next time—war permitting.

1. Proportionate cost in per cent per complete unit or part of product or structure produced by arc welding and treated in the paper, over that produced by the previous method.

The kind of contract under which these two boats are building is a participating contract, wherein a fixed limiting price is agreed upon and costs are kept with a predetermined overhead per cent. If a saving under the fixed cost is effected, a portion of the saving becomes additional profit to the contractor and a portion becomes added savings to the government. Since this is the first instance in which a dredge of this type has been welded in part and no previous records are available of work of this nature being done in this manner, concise figures are not possible until after final completion and tabulation of data.

The proportionate cost of the arc-welded portion of the *Hains* to the completed structure is estimated however as slightly over 50% of the total.

In the past 10 yr. few seagoing hopper dredges have been built by the government, the only agency building and operating them in this country.

This constitutes the first instance of a seagoing hopper dredge hull being welded even in part.

A building program involving a number of dredges in the 3 sizes of standardization (700 cu. yd.—3000 cu. yd.—5000 cu. yd.) has been proposed but more urgent war construction has not as yet made it possible. If any are built immediately the question of whether the hull will be riveted or welded will be determined by the availability of shipyard facilities irrespective of welding methods as an emergency measure.

If built after the emergency when facilities and procurement are more normal the trend is definitely toward welding for all future hulls of this type.

2. Estimated total annual cost saving occuring from:

(*a*) Use of arc welding by the company with which the author is connected in producing all products or structures of the type treated in this paper.

(*b*) Use of arc welding by industry, in general, in products or structures of the type treated in the paper.

(*a*) The U. S. Engineer Department was one of the earlier advocates of "electric" welding, so-called, when first introduced. This use included work all the way from thickening boiler sheets to steel pontoons and barge repairs and new construction. Gradually small boats and larger barges were included and numerous machinery repairs—especially dredging pump and impellers.

The *Hains* and the *Hoffman*, however, are the only two seagoing hopper dredges in which welding has played a part. It is expected others will follow when priorities permit.

(*b*) Since the U. S. Engineers are practically the only designers, builders and operators of seagoing hopper dredges the industry, in general, and the dredging contractors are not using welding in exactly the same or comparable fields. Contractors of dredging have confined their efforts to other types of dredges—principally pipe-line suction dredges. Many of the most recently built hulls for these contractor dredges have been welded throughout—probably 75% of them.

The estimated saving in weights of metal on new constructions is 12 to 15%. Maintenance cost annually is approximately 10%.

If the question of hulls of freight and passenger ships, which have a less strenuous life, are considered, the early future will, without a doubt, disclose extensive savings in the hull maintenance over riveted construction and an even greater saving in a seagoing hopper dredge where the continual and sudden changing of load stresses in the hull as the hoppers are discharged have in the past necessitated reriveting, particularly in the midship section.

3. Increased service life, efficiency and social advantages occurring from: the use of arc welding in producing all products or structures of the type treated in the paper.

As set forth above the use of arc welding on the building of a seagoing hopper dredge is an innovation. By the inherent nature of these great excavating machines severe strains and wear fall on the central section of the dredge. A heavy load of mud or sand is pumped aboard the hoppers and when the hopper gates are opened, the load is quickly discharged.

The hoppers must be tight or leaks will develop into the bilges of the dredge. Such leaks reduce carrying capacity until made tight in dry docks at a large expense. This is a costly operation when loss of dredging time is taken into consideration. Rivets work loose in the older riveted dredges and something must be done about it—hopper plates wear and must be built up or replaced. Welding has increased service life and efficiency by welding up the old riveted hoppers and over laying worn plates. Not only that but welding has made possible overlaying the places that wear most with special hard metal, and here again additional service life is added.

Time saved from repair lay ups on a dredge run quickly into money when you consider the larger standardized seagoing hopper dredge costs one dollar a minute to be idle and a single load missed means over 5000 cu. yd. of material undug. The stakes are high and welding is a real factor in keeping them operating.

A MICA MINE
IN A LABORATORY

War shortages crop up in strange materials. Mica, for instance. Once seen principally in the windows of stoves, and in small boys' pockets, it is now used extensively as electrical insulation. In some war products, it is virtually indispensable: capacitors for radio, spark-plugs for airplane engines, insulators in electronic tubes.

With demand mounting, manufacturers were desperate. A four-man technical mission flew to London to help ration the world's supply between the United States and Great Britain. The shortage was serious.

The War Production Board, convinced that much mica was classified too low when judged by appearance alone, asked Bell Telephone Laboratories to develop a new method of electrical tests. The Laboratories were able to do this quickly and successfully because of their basic knowledge and experience in this field.

The new tests were made available to manufacturers in this country and abroad—the supply of usable mica was increased 60% — and a difficult situation relieved.

Skill to do this and other war jobs is at hand in Bell Laboratories because, year after year, the Laboratories have been at work for the Bell System.

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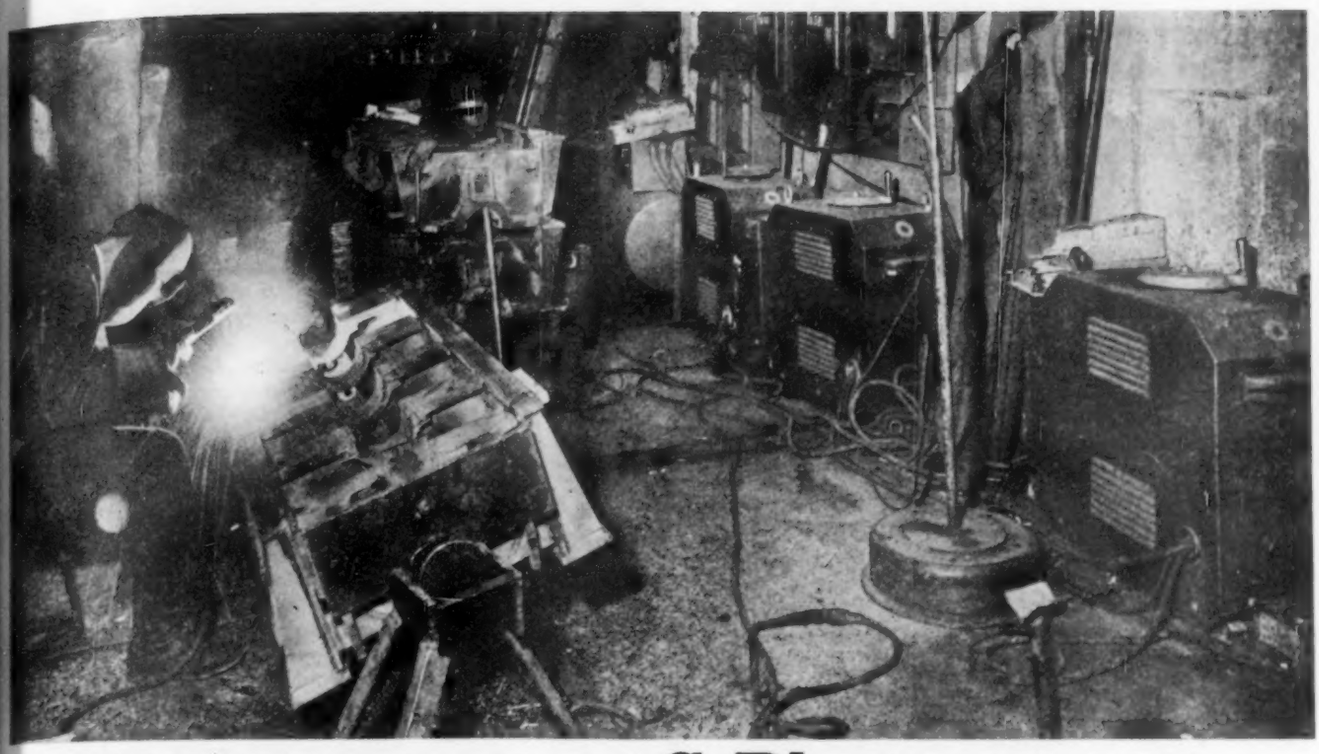

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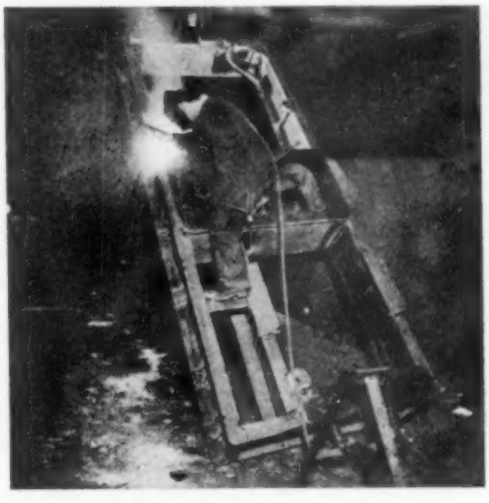

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THE AMERICAN WELDING SOCIETY

ACTIVITIES — RELATED EVENTS

NOMINATING COMMITTEE

With the approval of the Board of Directors the President has appointed the following members to constitute the 1944–45 Nominating Committee:

D. Arnott, Chairman, American Bureau of Shipping, New York, N. Y.
E. C. Brekelbaum, Harnischfeger Corp., W. Milwaukee, Wis.
J. C. Gowing, Owner, Los Angeles, Calif.
Milton Male, U. S. Steel Corp., Pittsburgh, Pa.
A. G. Oehler, Simmons-Boardman Publishing Co., New York, N. Y.
R. H. Taylor, The Electroloy Co., Inc., Bridgeport, Conn.
W. L. Warner, Watertown Arsenal, Watertown, Mass.

The By-Laws require that these names be published in the JOURNAL on or before March 1st. The Committee is required to deliver to the Secretary in writing on or before the 10th day of May, the names of its nominees for the various elected offices next falling vacant, together with the written acceptance of each nominee.

The purpose of publishing the names of the Nominating Committee in the JOURNAL is to provide every member with an opportunity to make suggestions to the Nominating Committee. To be effective it is essential that these suggestions be sent in at once as, naturally, the Nominating Committee will be required to hold early meetings in order to fulfill its duties as required by the By-Laws.

The offices to be filled are: President, First Vice-President, Second Vice-President (all for a term of 1 year) and four Directors (for a term of 3 years). Present incumbents of the offices of President and Second Vice-President are eligible for a second term. Present incumbent for the office of First Vice-President is not eligible for re-election to the same office, having served for a second term. The incumbents for Directors-at-Large are not eligible for re-election, according to the revised By-Laws, Article VIII, Section 7, which states that Directors shall not be eligible for re-election to the same office until at least one full term of 3 years shall have elapsed after the end of their respective terms. Although not yet adopted, it is expected the complete revision of the By-Laws will be consummated before the time of the annual election. The Directors-at-Large are selected by the Nominating Committee, with due consideration to geographic distribution.

Present officers whose terms expire next October are: *President*, A. C. Weigel; *1st Vice-President*, I. Harter; *2nd Vice-President*, W. F. Hess. *Directors:* H. C. Boardman, J. H. Critchett, E. V. David, R. S. Donald.

BOARD OF DIRECTORS MEETING

A meeting of the Board of Directors of the AMERICAN WELDING SOCIETY was held in the Board of Directors' Room, A.S.C.E., 29 West 39th St., New York, on December 15, 1944.

The meeting was called to order by President Weigel at 10:15 A.M., with the following present: H. C. Boardman, R. W. Clark, J. H. Critchett, E. V. David, G. N. Bull, representing J. F. Lincoln, J. H. Deppeler, O. B. J. Fraser, I. Harter, W. F. Hess, H. W. Lawson, J. F. Maine, H. W. Pierce and H. M. Priest.

By Invitation: H. O. Hill, *Chairman*, Outline of Work Committee and Past Chairman, By-Laws Committee.

Members of Staff: W. Spraragen, *Editor;* S. A. Greenberg, *Acting Technical Secretary;* and M. M. Kelly, *Secretary.*

Approval of Committee Personnel

On recommendation of the President and with the approval of the Chairmen of the Committees concerned, the following changes in the personnel of our standing committees were approved:

Addition.—Committee on Admissions: George Schneider, Acetylene & Welding Equipment Co., Brooklyn, N. Y.

Replacements.—Program Committee: D. E. Roberts, The Linde Air Products Co., New York City, replacing A. B. Kinzel of same organization. *Convention Committee:* J. L. Stover (Secretary, Publicity Committee), replacing C. J. McDonough, (Chairman of same Committee who was named for membership on the Convention Committee because of his office on Publicity Committee). *Manufacturers Committee:* C. T. Price, National Cylinder Gas Co., Chicago, Ill., replacing L. W. Smith of same company. *Membership Committee:* H. P. Etter, Air Reduction Sales Co., Los Angeles, Calif., replacing J. W. Lucas, Southwest Welding & Mfg. Co., Alhambra, Calif. Mr. Lucas declined, and Los Angeles Section proposed Mr. Etter as substitute.

Revised Edition A.W.S. By-Laws and Rulings of Board of Directors

Before calling for a presentation of this report, Mr. Weigel reminded the Board of the considerable amount of time and effort that had been spent by the former Chairman of the By-Laws Committee and the other members of his Committee in the preparation of a revised edition of the By-Laws which would eliminate ambiguities and conflicting provisions, and in submitting this revised document to the Directors and the Section Advisory Committee in advance of this meeting for study, with request for comments, it was the hope that the outcome of the discussion at this meeting would make possible publication (in the 1945 Year Book) of a set of By-Laws that would be in conformity with good practice.

Upon motion, duly seconded, it was voted that the revised edition of the By-Laws prepared by the By-Laws Committee and as amended at this meeting, be approved, and published in THE WELDING JOURNAL 30 days in advance of its submittal to the voting membership for adoption.

Finances

Report of Financial Operations for the Fiscal Year Ended September 30, 1944.—The Treasurer reported that the year just ended was the most prosperous in the history of the Society, largely attributable to yield of dues from increased membership, increased Journal advertising and subscriptions, and lower figures for several items of expense than were expected at the start of the year. Our net worth was 5% better than at the close of the previous year. The considerably larger excess of income over expense this year as compared with a year ago made it possible to underwrite completely the cost of retirement pension annuities for four members of headquarters staff who have been with the Society the longest.

Budget for Fiscal Year Commencing October 1944.—The proposed budget and accompanying explanatory letter, submitted by the Treasurer to the Directors under date of December 8th and read by the Treasurer at this meeting, were discussed and approved.

Metal Congress and Exposition

Mr. David reported as follows on the status of the 1945 National Metal Congress and Exposition:

Selection of location of the 1945 National Metal Exposition remains unsettled. Under date of December 9th, Mr. Eisenman reported that communications have been received from societies that participated in the 1944 Exposition, indicating a desire to participate in the 1945 Show.

The situation relative to possible convention cities is quite complicated because of two factors: (1) unwillingness of the hotels to make any large commitments of rooms for the Congress; (2) absence or improbability of a building to house the Exposition.

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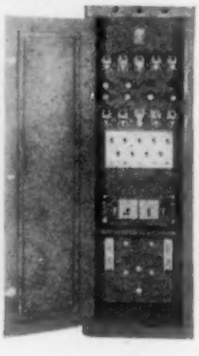

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Proposal for staggering the meetings of A.W.S. and A.S.M. so that the smaller number of rooms available, when extended over a two-week period, would equal the room requirements for a one-week period with a metals show of sufficient duration to overlap the two Societies' meetings was discussed by Mr. Eisenman with us and also with Mining Engineers and it seemed to be the solution for relieving the housing situation. The situation on the only two prospective convention cities is as follows:

Philadelphia—has offered to allocate 3000 rooms in the three principal downtown hotels for the week of October 15th, and the same number of rooms for the week of October 22nd when the A.W.S. would come in. Convention Hall in Philadelphia, including the arena, exhibit hall and Commercial Museum *may be* available.

Cleveland—Mr. Eisenman has an option on the exhibit facilities of the Cleveland Public Auditorium for the third full week in October. Also, options on the complete facilities of Cleveland hotels for both the week of the 15th and the 22nd. If the entire facilities of Cleveland are made available for the full two weeks and the meetings are staggered, he believes that satisfactory conditions might be worked out.

Mr. Eisenman has, therefore, made recommendations to his Board of Trustees that if the Philadelphia Hall becomes available and the stagger system is put into effect, Philadelphia be designated as convention city. If the Philadelphia Convention Hall does not become available previous to the time when it becomes necessary to send out floor plans, he has recommended that the Board consider seriously holding the Show in Cleveland using the stagger system for the meetings of technical societies. His Board of Directors acted favorably on his suggestion of the stagger system and also upon selection of Philadelphia as a first choice and Cleveland as a second choice.

It was the general feeling that the stagger system proposed for 1945 is the immediate step, and the results of this venture will prove valuable to the Manufacturers Committee in determining the necessity or desirability of A.W.S. holding a separate welding show.

Recommendations of the Outline of Work Committee

The following proposals offered by the Outline of Work Committee for consideration and the actions taken thereon are recorded below:

(*a*) *Revision of Rules to Govern Technical Committees on Recommendation of Outline of Work Committee.*—It was, upon motion, duly seconded, voted to add to rules governing technical committees the following section:

"14. A technical committee may recommend to the Technical Activities Committee, or the Technical Activities Committee may recommend to a technical committee, the reorganization of personnel of that technical committee when such action seems necessary for the proper functioning of the technical committee. Such proposed plan of reorganization shall be approved by the Technical Activities Committee before any action toward reorganization is undertaken."

(*b*) *A.W.S. Representative on Subcommittee II—A.S.T.M. Committee A-1 on Structural Steel for Bridges and Buildings.*—It was voted to designate Mr. C. [illegible] Loos, Carnegie-Illinois Steel Corp., to represent the A.W.S. on Subcommittee II—A.S.T.M. Committee A-1—Structural Steel for Bridges and Buildings, with the understanding that approval of this appointment by the Chairman of A.S.T.M. is to be obtained.

(*c*) *Appointment of A.W.S. Automotive Welding Committee.*—It was voted to approve recommendation of the Outline of Work Committee for the appointment of an A.W.S. Automotive Welding Committee, with scope and personnel as outlined below.

Scope: Because of the many production conditions peculiar to the automotive type of fabrication, a great many problems have arisen in the use of welding as a fabricating process in this industry that are not satisfied by the material available through A.W.S. today. Therefore it is firmly believed that an A.W.S. Automotive committee would prove a very valuable benefit to this industry as well as the AMERICAN WELDING SOCIETY.

The purpose of this committee shall be to bring together into one group representatives of the automotive manufacturing industry including their supplier that are using welding processes in their production fabrication in order to bring a concerted effort toward the solution of the welding problems peculiar to this industry. This committee would act on such problems by either delegating subcommittees for their solution or by referring them to the proper A.W.S. committee already in existence. This committee would be active in establishing standards on all fusion and resistance welding procedures related to sheet metal fabrication. Other functions of this committee would be to permit free exchange of ideas within this group and act as a means of seeing that worth-while ideas are given to the rest of the industries through A.W.S.

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Personnel: J. M. Diebold, *Temporary Chairman*, General Motors Corp.; C. D. Evans, *Vice-Chairman*, International Harvester Co.; S. A. Greenberg, *Secretary*.

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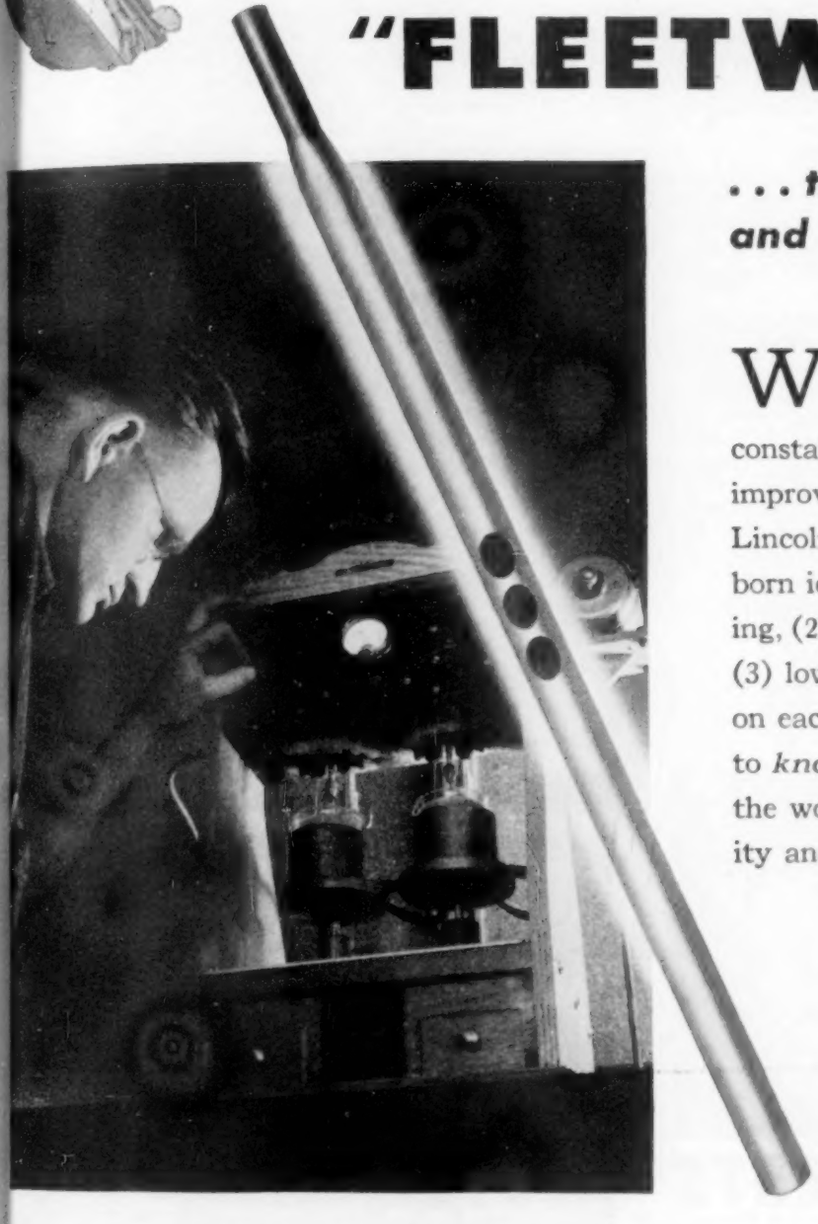
"Pay Attention to the Future," *he says*

LOOK, MR. KETTERING, how recourse to "Fleetweld" electrodes helps assure a successful future for arc welded products.

"FLEETWELD"



. . . the standard of quality and economy is constantly improved

WORLD-WIDE contacts, made by skilled Lincoln engineers, provide a constant flow of suggestions for continuous improvement of "Fleetweld" electrodes. Lincoln research men translate these field-born ideas into (1) faster and faster welding, (2) higher and higher weld quality and (3) lower and lower cost. THREE DOTS on each "Fleetweld" electrode enable you to *know* you have the genuine article . . . the world's standard of arc welding quality and economy.

Complete details and procedures for six types of "Fleetweld" and for 32 other Lincoln electrodes are given in the "Weldirectory." Free on request.

THE LINCOLN ELECTRIC COMPANY
Cleveland 1, Ohio

Another **LINCOLN** *Contribution to . . .*

America's greatest natural **recourse**

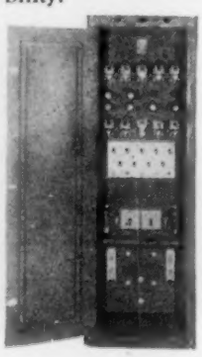
ARC WELDING

electronic Weltronic bulletins

COMPLETE SPOT AND PULSATION CONTROL INCLUDES "POST-HEAT"

The new Weltronic Model 86 Welder Control makes available for the first time in one cabinet complete controls for selective operation of either spot or pulsation welding, *with or without post weld heat treatment.* Compact "package" unit design incorporating a highly versatile timer, pulsation counter, dual heat control and universal contactor eliminates the necessity for inter-unit wiring and phasing.

Timer provides independent, wide range, accurately calibrated dial adjustment of Squeeze, Heat, Cool, Chill, Anneal, Hold and Off times—plus a pulsation counter. Dual phase-shift heat control permits separate stepless, automatic control of weld and temper heats plus independently adjustable weld and anneal intervals. Universal tube contactor accommodates all size ignitrons from A to D. Exclusive Weltronic circuits requiring fewer, less expensive tubes insure a minimum of maintenance in addition to providing a high degree of operational flexibility.



Ask for bulletin No. *WT 86*

Weltronic COMPANY

DETROIT 19, MICH.

Proposal for staggering the meetings of A.W.S. and A.S.M. so that the smaller number of rooms available, when extended over a two-week period, would equal the room requirements for a one-week period with a metals show of sufficient duration to overlap the two Societies' meetings was discussed by Mr. Eisenman with us and also with Mining Engineers and it seemed to be the solution for relieving the housing situation. The situation on the only two prospective convention cities is as follows:

Philadelphia—has offered to allocate 3000 rooms in the three principal downtown hotels for the week of October 15th, and the same number of rooms for the week of October 22nd when the A.W.S. would come in. Convention Hall in Philadelphia, including the arena, exhibit hall and Commercial Museum *may be* available.

Cleveland—Mr. Eisenman has an option on the exhibit facilities of the Cleveland Public Auditorium for the third full week in October. Also, options on the complete facilities of Cleveland hotels for both the week of the 15th and the 22nd. If the entire facilities of Cleveland are made available for the full two weeks and the meetings are staggered, he believes that satisfactory conditions might be worked out.

Mr. Eisenman has, therefore, made recommendations to his Board of Trustees that if the Philadelphia Hall becomes available and the stagger system is put into effect, Philadelphia be designated as convention city. If the Philadelphia Convention Hall does not become available previous to the time when it becomes necessary to send out floor plans, he has recommended that the Board consider seriously holding the Show in Cleveland using the stagger system for the meetings of technical societies. His Board of Directors acted favorably on his suggestion of the stagger system and also upon selection of Philadelphia as a first choice and Cleveland as a second choice.

It was the general feeling that the stagger system proposed for 1945 is the immediate step, and the results of this venture will prove valuable to the Manufacturers Committee in determining the necessity or desirability of A.W.S. holding a separate welding show.

Recommendations of the Outline of Work Committee

The following proposals offered by the Outline of Work Committee for consideration and the actions taken thereon are recorded below:

(*a*) *Revision of Rules to Govern Technical Committees on Recommendation of Outline of Work Committee.*—It was, upon motion, duly seconded, voted to add to rules governing technical committees the following section:

"14. A technical committee may recommend to the Technical Activities Committee, or the Technical Activities Committee may recommend to a technical committee, the reorganization of personnel of that technical committee when such action seems necessary for the proper functioning of the technical committee. Such proposed plan of reorganization shall be approved by the Technical Activities Committee before any action toward such reorganization is undertaken."

(*b*) *A.W.S. Representative on Subcommittee II—A.S.T.M. Committee A-1 on Structural Steel for Bridges and Buildings.*—It was voted to designate Mr. C. [illegible] Loos, Carnegie-Illinois Steel Corp., to represent the A.W.S. on Subcommittee II—A.S.T.M. Committee A-1—Structural Steel for Bridges and Buildings, with the understanding that approval of this appointment by the Chairman of A.S.T.M. is to be obtained.

(*c*) *Appointment of A.W.S. Automotive Welding Committee.*—It was voted to approve recommendation of the Outline of Work Committee for the appointment of an A.W.S. Automotive Welding Committee, with scope and personnel as outlined below.

Scope: Because of the many production conditions peculiar to the automotive type of fabrication, a great many problems have arisen in the use of welding as a fabricating process in this industry that are not satisfied by the material available through A.W.S. today. Therefore it is firmly believed that an A.W.S. Automotive committee would prove a very valuable benefit to this industry as well as the AMERICAN WELDING SOCIETY.

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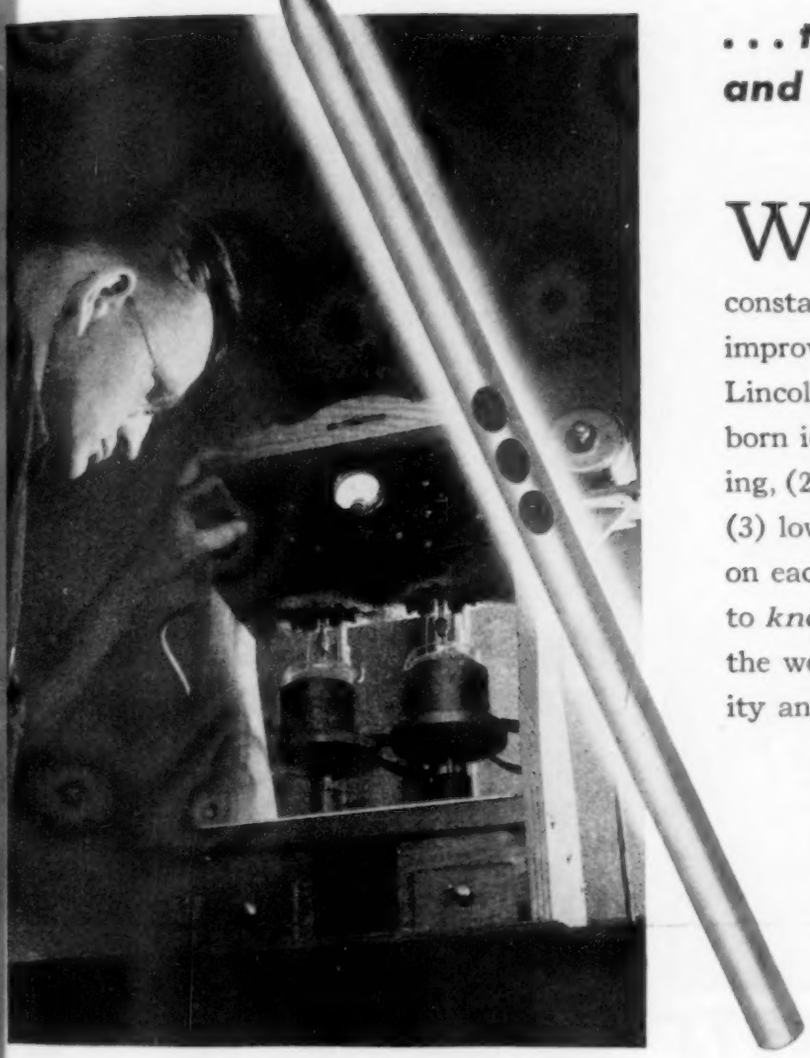

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Another LINCOLN *Contribution to . . .*

America's greatest natural recourse

ARC WELDING

W. E. Crawford, A. O. Smith Corp.; C. D. Evans, International Harvester Co.; Harold Sparks, Chrysler Corp.

Main Committee: Briggs Body Corp., Edward G. Budd Manufacturing Co., Chrysler Corp., Diamond T Truck Co., Firestone Tire and Rubber Co., Ford Motor Co., Freuhauff Trailer Co., General Motors Corp., Hayes Body Co., Hudson Motor Co., International Harvester Co., Kelsey Hayes Corp., Mack Truck, Motor Wheel Co., Midland Steel Corp., Mullins Co., Murray Corp., Nash Kelvinator Co., Noblitt Sparks Co., Packard Motor Co., A. O. Smith Corp., Studebaker Co., Timken-Detroit Axle Co., White Motor Co., Willys Overland Co., Walker Michigan Co., Wheeling Steel Corp., L. A. Young Spring & Wire Corp.

(There are several others who are considered distinct possibilities as members of this committee, but it is believed that the membership listed above is as large as is really desirable at this time; and while this committee should represent this field of industry fairly, it should not become too ponderous or it will lose its value.)

(*d*) *Appointment of A.W.S. Committee on Brazing.*—It was voted that the report of the Investigating Committee on Brazing be accepted and the A.W.S. Committee on Brazing be organized with scope and personnel given below.

Scope: The Committee on Brazing shall be concerned with the establishment of standards and recommended practices for the various brazing processes. These activities would include data on design, fabrication practices, inspection practices and test methods, definitions and symbols, as required for the various applications of these brazing processes.

*Personnel:** *Temporary Chairman,* C. E. Johnson or J. R. Wirt (if Mr. Johnson declines); S. A. Greenberg, *Acting Secretary.* (Producers) American Brass Co. (I. T. Hook or Chas. Davis), Chase Brass Co. (J. J. Vreeland), Aluminum Co. of America (G. O. Hoglund), Handy & Harman (R. H. Leach), Linde Air Products Co., Air Reduction Sales Co., Eutectic Welding Alloys Co., 2 or 3 additional producers of heavy, brazing alloys. (Consumers) Bureau of Ships, General Electric Co., G. M. C. Frigidaire Co. (Geo. Long), Federal Shipbldg. Corp., Carrier Corp., Allis-Chalmers Mfg. Co., Bell Aircraft, Consolidated-Vultee Aircraft, Westinghouse Elec. & Mfg. Co. (A. K. Phillips), Scaife Company (C. E. Johnson), Bell Telephone Labs., Delco Remy Division, General Motors Co. (J. R. Wirt).

(*e*) *Change in Name Committee on Outline of Work.*—With the understanding that the Technical Activities Committee will be concerned only with the planning and development of welding codes, standards, procedures and practices, it was, upon motion, duly seconded, voted to accept recommendation of the Committee on Outline of Work that the name of this Committee be changed to Technical Activities Committee.

* Names shown in parentheses following companies listed are suggested representatives.

Mr. Hill further reported, as a matter of information, that Mr. C. H. Jennings had been elected Vice-Chairman of the Technical Activities Committee for a term ending October 1945, to fill vacancy caused by the elevation of Mr. H. O. Hill to the Chairmanship.

He further reported that an Executive Subcommittee, comprising of Messrs. H. O. Hill, *Chairman,* S. A. Greenberg, *Secretary,* O. B. J. Fraser, T. R. Higgins, C. H. Jennings, H. W Pierce and Wilson Scott, has been appointed to act in an advisory capacity to the Technical Activities Committee in reviewing and guiding the Technical Committee activities in the periods between regular meetings of the Technical Activities Committee.

Appointment 1945 National Nominating Committee

In accordance with Article XII, Section 7 (revised edition) of A.W.S. By-Laws, which requires publication of personnel of Nominating Committee in THE WELDING JOURNAL on or before March 1st, the President offered for approval personnel named below: D. Arnott, *Chairman,* New York, N. Y.; E. C. Brekelbaum, Milwaukee, Wis.; J. C. Gowing, Los Angeles, Calif.; Milton Male, Pittsburgh, Pa.; A. G. Oehler, New York City; R. H. Taylor, Bridgeport, Conn.; W. L. Warner, Watertown, Mass.

It was voted to approve recommendations of the President for personnel of the 1945 Nominating Committee as listed above.

BRASS MAKES BULLETS

REGO Gas Plant Equipment to be safe, must be made of brass and other critical metals.

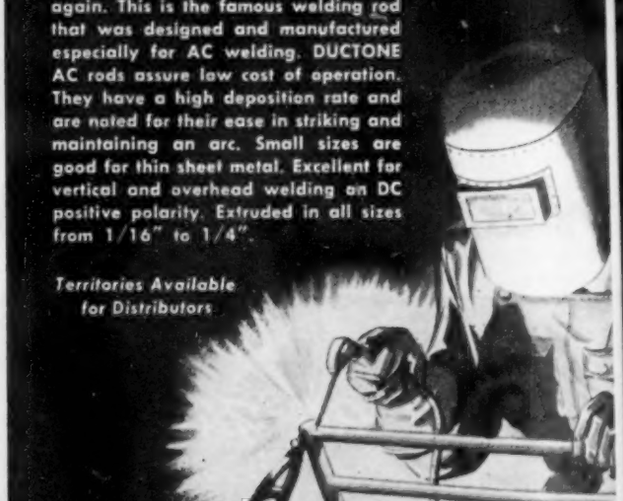
Conserve your equipment. You may not get more.

The BASTIAN-BLESSING Co.
4241 W. PETERSON AVE. CHICAGO
Pioneers and Manufacturers of Precision Equipment for Using and Controlling High Pressure Gases

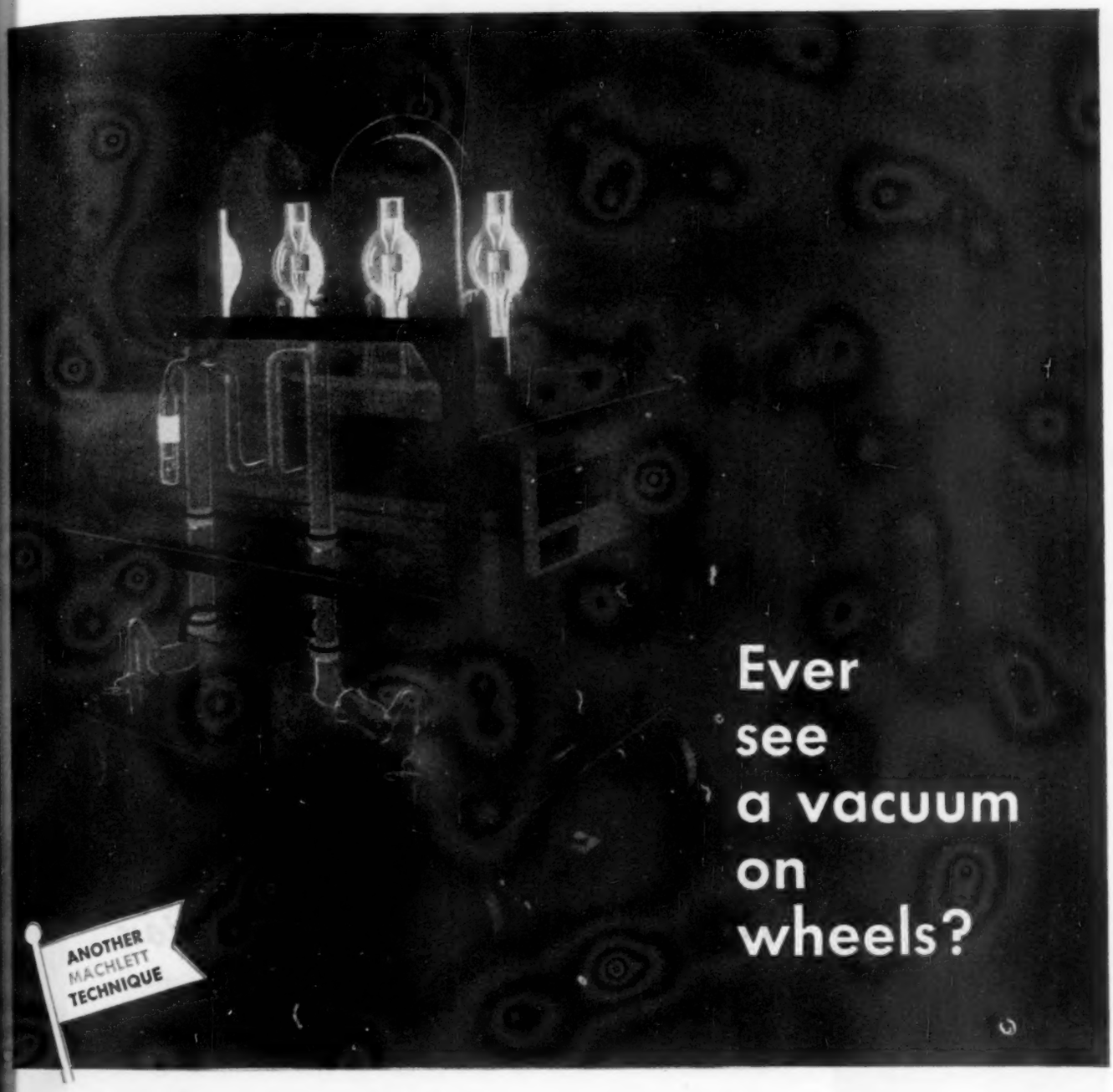
Best for AC General Purpose
DUCTONE AC
(E6011 AND E6013)
WELDING RODS

Ductone AC electrodes are available again. This is the famous welding rod that was designed and manufactured especially for AC welding. DUCTONE AC rods assure low cost of operation. They have a high deposition rate and are noted for their ease in striking and maintaining an arc. Small sizes are good for thin sheet metal. Excellent for vertical and overhead welding on DC positive polarity. Extruded in all sizes from 1/16" to 1/4".

Territories Available for Distributors



Reach for DUCTONE AC Welding Rods
Chicago Steel and Wire Co.
103rd St. and Torrence Ave.
Chicago 17, Illinois



The final stages of manufacture of X-ray and other electronic tubes must include thorough "outgassing" to remove gases held within the metal tube parts, as well as the gas inside the glass envelope. This has customarily been done in three separate operations, and it was considered inevitable for two-thirds of the equipment to be idle while one-third was in operation. Machlett felt that this produced highly undesirable effects on output, costs, and on tube quality.

So we developed a unique production line. The tubes are sealed on a high-vacuum pump which is mounted on a dolly, and thus can be wheeled through each operation, while pumping continues steadily. The dolly goes first to a baking oven (shown above); then to a station in which the tube elements are heated red hot by induction; finally they are bombarded repeatedly at 70,000 volts. This is about 10 times the usual voltage, and not only reduces the time required in a later seasoning process, but assures much better tubes.

The system approximately triples the output of the equipment. That alone was invaluable in meeting tremendous war orders. But we also believe that it produces tubes with less residual gas and hence improved operation and longer life. When buying X-ray tubes for medical, dental, scientific or industrial purposes, or radio tubes for communications or industry, remember this Machlett technique which makes possible the production of the tube shown above . . . Machlett Laboratories, Inc., Springdale, Connecticut.

ML-861, screen-grid r-f oscillator and amplifier tube.

MACHLETT

X-RAY TUBES SINCE 1898

TODAY THEIR LARGEST MAKER

Employment Service Bulletin

SERVICES AVAILABLE

A-492. Three years' experience as an Arc Welder. Attending school studying Gas Welding. Would like connection with job shop doing all position welding. New York or vicinity.

A-493. Welding Engineer. Experience in instructing, engineering, supervision and service. Technical knowledge and practical experience in the application of Lincolnweld and Unionmelt Automatic, Atomic-Hydrogen, Oxyacetylene Pressure Welding, Metallic Arc, Carbon Arc, Oxyacetylene and Oxy-hydrogen Welding; also flame cutting, gouging and scarfing. Young, intelligent, aggressive.

POSITION VACANT

V-153. Welding Foreman. Man experienced in gas and atomic hydrogen welding of stainless steel. Applicant must be capable of assuming full supervision and have the ability to instruct welder trainees.

3000TH MILE OF INVASION TUBING

The two plants of the Babcock & Wilcox Co. in Alliance, O., have started production on their three-thousandth mile of welded invasion tubing used to pipe oil and other necessary fuels to the front, it was announced on December 28 by officials of the company. The two mills have produced a substantial portion of the country's total output of 4-in. (outside diameter) tubes for invasion pipe lines. A single welding unit in one plant produces between 10 and 12 miles a day of the tubing, and capacity production is between 20 and 25 miles a day.

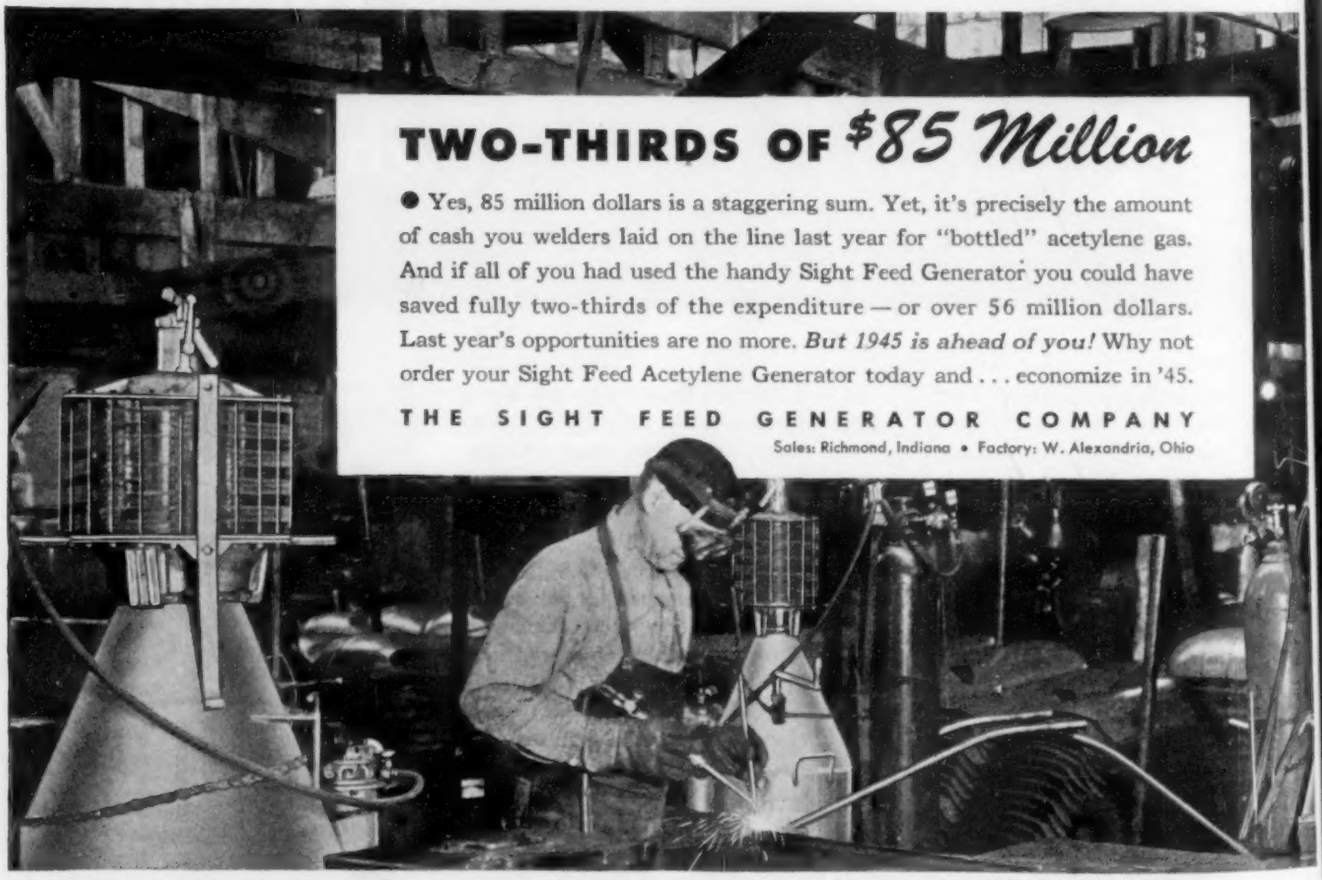
The pipe is made in lengths of 20 ft., 4 in. in diameter, of 14-gage low-carbon steel. The thickness is only slightly more than that of an automobile fender. Weighing 67 lb., the tubes are light enough for a single man to handle, allowing quick action in the field. Three squads of men can lay between 70 to 80 miles of tubing a day.

The lengths are joined together in the field by means of a standard coupling device and a rubber gasket. The grooved ends of two joints of the tubes are connected and gathered, then the bolts in the coupling tightened, and another length of the line to victory has been laid. This operation repeated on 264 lengths completes a mile.

These pipe lines have played an important part in the Sicilian, North African and Normandy invasion campaigns. No longer is the old adage true about an army traveling on its stomach. Today it travels by means of these steel arteries which convey the necessary fluids of mechanized warfare. One petroleum pipe line carries enough fuel to free 250 trucks for other purposes. Unlike a truck convoy, the pipe line makes such a poor bombing target that a 100-lb. bomb must strike within a few feet to be effective. One such pipe line requires only one-tenth the manpower needed for tanker-truck transport.

PHILADELPHIA SECTION TO CELEBRATE SILVER ANNIVERSARY IN MARCH 1945

Plans are being completed for a Dinner to mark the twenty-fifth anniversary of the first Section of the AMERICAN WELDING SOCIETY, it is announced by Mr. William H. Barnes, chairman of the committee in charge. The Dinner is to be held Monday evening, March 19th, at the Engineers' Club in Philadelphia. Dr. C. A. Adams, first President of the Society and at present a member of the Philadelphia Section, Mr. A. C. Weigel, President, Mr. Isaac Harter, First Vice-President, Miss M. M. Kelly, National Secretary, and Mr. William Spraragen, WELDING JOURNAL Editor, will be among the honored guests. In addition to Mr. Barnes, Messrs. T. M. Jackson, J. W. Meadowcroft and R. D. Thomas are some of the founder members who will be on hand to welcome the members and guests of the Section. It is hoped that former members now located in other parts of the country will, if possible, join in the celebration.


TWO-THIRDS OF $85 Million
● Yes, 85 million dollars is a staggering sum. Yet, it's precisely the amount of cash you welders laid on the line last year for "bottled" acetylene gas. And if all of you had used the handy Sight Feed Generator you could have saved fully two-thirds of the expenditure — or over 56 million dollars. Last year's opportunities are no more. But 1945 is ahead of you! Why not order your Sight Feed Acetylene Generator today and . . . economize in '45.
THE SIGHT FEED GENERATOR COMPANY
Sales: Richmond, Indiana • Factory: W. Alexandria, Ohio

"ECONOMIZE IN '45 . . . WITH Sight Feed"

X-ray Inspection Reveals . . .

THE WHOLE TRUTH

and nothing but

with KELEKET'S NEW X-RAY UNIT

With X-ray you can check every inch of a weld and *know* it is right—or instantly spot any slag inclusion, porosity, lack of fusion or other imperfection. As faults can be corrected only when they are known, and as the *whole* story is on the film, inspection by X-ray points the way to perfecting your welding technique.

KELEKET—known the world over for installations in many plants, large and small—has developed for Industry the simplest X-ray unit ever built, the KELEKET 250. Scores of X-ray users who visited the National Metal Congress were instantly impressed with its automatic controls, its safety signals. Manual steps have been reduced to a minimum—the *machine* does *more*, the *operator* does *less*. And it has plenty of power and penetration to cover the widest range of welding inspection requirements.

X-ray need not interrupt your production flow. Consult a KELEKET sales engineer for the know-how of an X-ray department—or write Covington direct for full information.

KELLEY-KOETT X-RAY MFG. COMPANY

2182 WEST FOURTH ST., COVINGTON, KY.

KELEKET—THE FINEST TRADITION IN X-RAY

AIR REDUCTION ANNOUNCES NEW APPOINTMENTS

C. D'W. Gibson, Vice-President in Charge of Sales of Air Reduction, has announced the following appointments effective January 1, 1945.

H. F. Henriques, formerly Sales Manager of the North Central Division, is appointed General Sales Manager. J. J. Lincoln, formerly Sales Manager of the South Central Division, is appointed Director of Sales Services. C. M. Bloodgood, who has been serving as Sales Manager of the Pacific Coast Division, is appointed Assistant to the Vice-President in Charge of Sales.

All of the above new appointees will have offices at 60 East 42nd St., New York 17, N. Y.

H. P. Etter, heretofore Manager of the Los Angeles District of Air Reduction, is appointed Sales Manager of the Pacific Coast Division with headquarters in the Mills Tower Bldg., San Francisco, Calif.

PRACTICAL DESIGN FOR ARC WELDING

Practical Design for Arc Welding, Vol. 2, by Robert E. Kinkead; 100 additional welding design plates, cloth bound, $8^3/_4$ x $11^1/_2$ in., published by The Hobart Brothers Co., Hobart Square, Troy 1, Ohio. Price per volume, $3.50.

Taking up where the first volume left off, this second volume of *Practical Design for Arc Welding* presents 100 new and entirely different "idea stimulators" for use by designers, engineers and fabricators who are interested in making the most of welding equipment now on hand or to be installed.

In selecting the 100 design ideas for this second book, Mr. Kinkead has paid considerable attention to fabrication of tubular members and connections. Many of these ideas will be found applicable both to piping installations and to tubular structural design.

This second book merits the same enthusiasm that is being accorded the first volume of this Design for Arc Welding series. (For those who do not have access to Vol. I, it, too, is available from The Hobart Brothers Co., Troy, Ohio, $3.50 per volume.)

HIGH-SPEED MACHINE GAS CUTTING TIPS

A new 12-page, four-color bulletin, No. ADG-2008, describing the Airco "45" and "45M" high-speed machine gas cutting tips which control the expansion of cutting oxygen, has been published by Air Reduction.

Cross-sectional drawings and photographs clearly show how the especially designed orifices in these tips release a high-velocity stream of oxygen to cut a narrower path or kerf than the standard cutting tips. Cutting steel plate of various thicknesses up to 8 in., both tips give the user better than a 20% increase in cutting speed with no increase in gas consumption per inch of cutting. Photographs show how the newer "45M" tip is designed for heavier preheat making it particularly adaptable for cutting rusty and scaly plate, bevel cutting, and cutting with hydrogen as a fuel gas.

Other illustrations, including charts and tables, give valuable specifications data for both the "45" and "45M" tips. Copies of bulletin ADG-2008 are available on request from Air Reduction Sales Company, 60 East 42nd St., New York 17, N. Y., or any local Airco office.

BRAZING CARBIDE TOOL TIPS

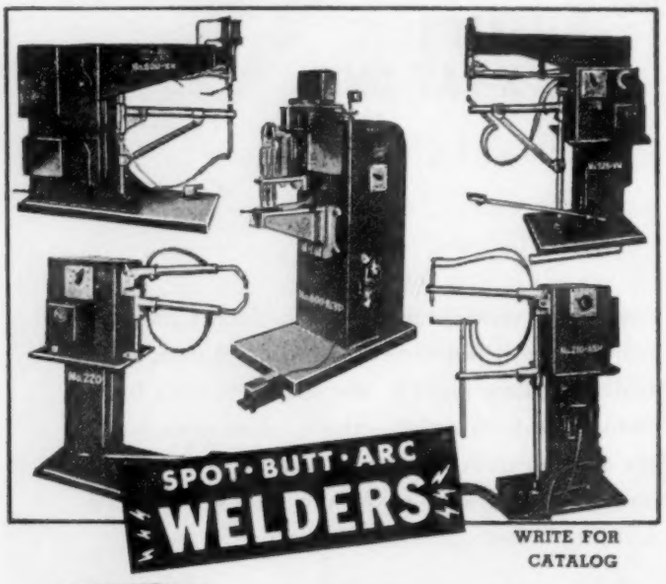
Handy & Harman, 82 Fulton St., New York have issued a new Bulletin 11-A on the subject of Brazing Carbide Tool Tips with Easy-Flo No. 3, which has a flow point of 1270° F.

A copy of this bulletin will be mailed to anyone upon request to the company.

SHEET METAL—THEORY AND PRACTICE

By John C. Butler

For sheet metal workers—a concise, practical, *tested* self-instruction guide giving methods of handling successfully: Tools and Machines; Material Allowances; Blueprint Reading; Soldering,



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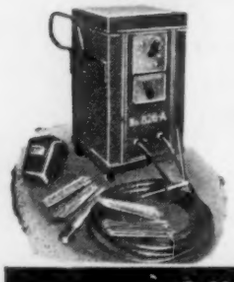


We manufacture a complete line of resistance spot welders from ¼ to 300 KVA for all types of welding. There is an EISLER WELDER for every purpose.

TRANSFORMERS OF ALL TYPES

WE INVITE CONTRACT SPOT WELDING IN LARGE OR SMALL QUANTITIES.

CHAS. EISLER
EISLER ENGINEERING CO.
779-SO. 13th ST. Near AVON AVE. NEWARK, 3 N. J.

FREE

ENGINEERING INFORMATION

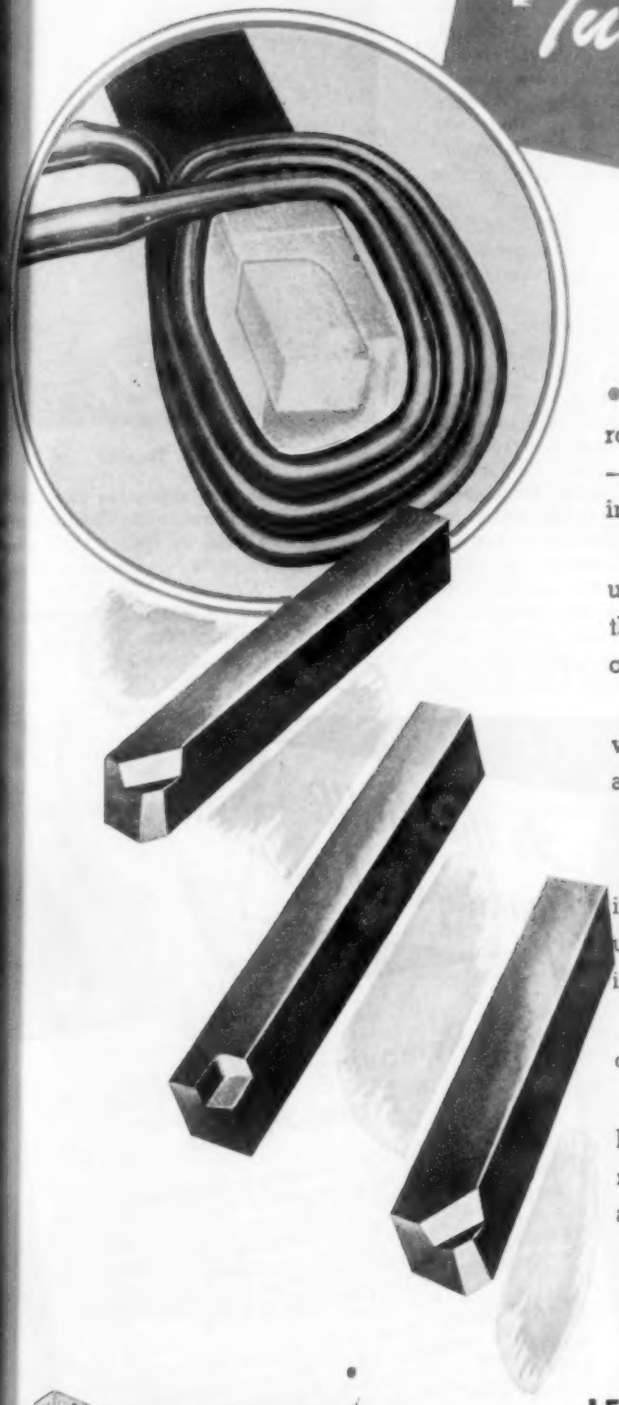
for BETTER WELDING

This New Engineering Bulletin contains important technical information that may save you time, labor and money on many welding jobs. Learn how to keep welding jigs free of spatter; how to save mill-scale cleaning time after normalizing; how to reduce fumes; etc. etc. Contains actual case histories and laboratory authenticated reports. Write for your copy now.

WELDING SUPPLY DISTRIBUTORS AND SALESMEN WANTED

The MIDLAND PAINT & VARNISH CO.
9126 RENO AVENUE CLEVELAND 5, OHIO

A BETTER WAY to Braze Tungsten Carbide Cutting Tools



• Lepel Induction Heating Equipment — in the toolroom as in many leading tool manufacturing plants — removes the uncertainty from the operation of brazing tungsten carbide cutting tips.

Automatically-controlled heating cycles insure uniform brazing and a uniformly sure bond between the tip and the shank without danger of losses from overheating.

Brazing alloys of any melting point can be used with equal assurance, permitting selection of the alloy best suited to the service requirements.

Actual brazing time is cut to a matter of seconds.

Heating coils for various tool sizes and shapes are instantaneously interchangeable and the same setups can also be used for removing worn tips without injury to either tip or shank.

The operation is so simple and foolproof that anyone can do a good job every time.

The same compact, easily-movable unit can also be used for heating for hardening, annealing, stress-relieving, forging, production brazing or soldering, and for melting all ferrous and non-ferrous metals.

Write for complete information.

Lepel High Frequency INDUCTION HEATING UNITS

LEPEL HIGH FREQUENCY LABORATORIES, INC.

PIONEERS IN INDUCTION HEATING

General Offices: 39 West 60th Street, New York 23, N. Y.

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Fluxes; Welded and Riveted Assembly, used in today's Sheet Metal shop practice. Price $3.00. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y.

ARC WELDING

Engineering and Production Control

By Walter J. Brooking, R. G. LeTourneau, Inc.

A manual of the arc-welding process as applied in manufacturing and fabrication, drawing largely on typical industrial experience for a helpful blend of the shop skills and technical know-how required by operators, inspectors, engineers and others concerned with the use of the process. Discusses fully the significance of materials, fixtures, engineering control, process planning and organization, and other factors, and shows how to analyze them as a basis for the effective application of arc welding to specific manufacturing problems. Price $4.00. Published by McGraw-Hill Book Co., Inc., 330 West 42nd St., New York 18, N. Y.

PULLMAN INC. BUYS M. W. KELLOGG CO., ENGINEERING FIRM

Pullman Incorporated announced that it will acquire for cash, with price to be finally determined in accordance with conditions of the sale contract, the entire outstanding stock of The M. W. Kellogg Co. of Jersey City, N. J., for many years a leading firm in the field of petroleum and chemical engineering.

The announcement, made jointly by D. A. Crawford, president of Pullman Incorporated, and M. W. Kellogg, president of the M. W. Kellogg Co., said, "the Kellogg Company will be operated as a separately incorporated member of the Pullman group of companies, with the present staff of officers and employees, and continuing as a specialized research, manufacturing and engineering-construction company along the lines which have given Kellogg leadership in its field for more than a quarter of a century."

It was also announced that M. W. Kellogg has been elected a member of the Board of Directors of Pullman Incorporated.

"By acquisition of the Kellogg Company," the statement said, "the Pullman group will participate in more diversified lines of engineer-contracting, research and manufacturing activities than heretofore, and it is expected that advantageous results will be effected. From the point of view of the Kellogg Company the change is expected to open new opportunities for service to the oil-refining and other industries through substantially expanded facilities made possible by increased resources. It also carries the prospect of expansion into other fields where these enlarged facilities may be applied."

TINNON PROMOTED

The Metal and Thermit Corp. announces the election of John B. Tinnon and Walter S. Smith to the Board of Directors of the corporation.

John B. Tinnon

Mr. Tinnon was appointed Sales Manager in 1928 and was made Vice-President in Charge of Sales in 1942. Mr. Tinnon has long been active in the affairs of the AMERICAN WELDING SOCIETY. He has served as Chairman of the Manufacturers Committee, Membership Committee and Meetings & Papers Committee.

This is particularly true of machine tool bases, frames, levers; of diesel engine frames and gear casings; equipment for paper mills; crane and hoist parts; manifolds, blower housings; parts for the great majority of electrical appliances, etc.

Welded construction is almost always stronger, yet lighter—also more sightly and often less costly.

Study your product. Arrange to weld as much of it as possible. Consult United engineers on new plans, or submit present plans for study and estimates.

THE UNITED WELDING CO.
MIDDLETOWN, OHIO
WELDING FABRICATORS OF MODERN DESIGNS

Is this YOUR Cleaning Problem?
Removing Oxide Film From Alclad
Then benefit by the successful experience of leading companies that now are using Oakite Compound No. 84A. You, too, will find that the more effective action of this specialized material quickly produces a surface of low, uniform resistance . . . thereby making possible BETTER spot welds and MORE welds WITHOUT CHANGING TIPS.
For full details, write us for Special Service Report that also describes other Oakite materials now widely used in the surface preparation of aluminum before spot welding. Send for your FREE copy TODAY!
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Technical Service Representatives Conveniently Located in All Principal Cities of the United States and Canada
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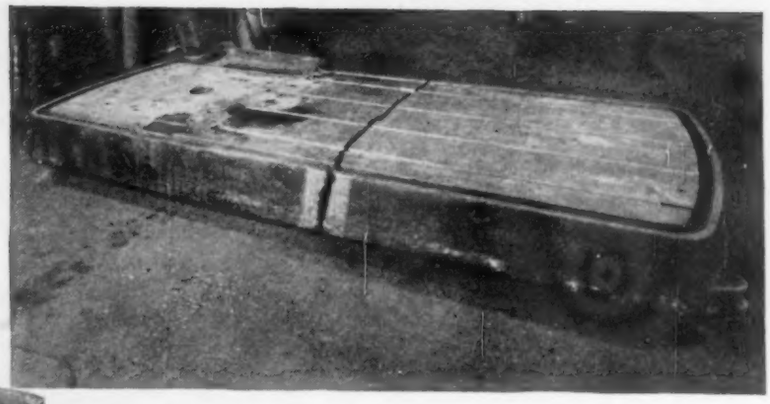
MATERIALS · METHODS · SERVICE

TOBIN BRONZE WELDING



plugs gap in tank production line

IN MOVING a radial drill press needed on an Army tank production line, the 5,250 lb. base fractured completely through.

Repair welding with Tobin Bronze* Rod was undertaken by the Super Arc Welding Co., of Detroit and the press was successfully returned to service.

Preparation, requiring 54 man-hours, involved chipping out the break at each of the "T" slots so that these slots could be machined after welding without loss of strength.

Actual welding required 85 man-hours and 350 pounds of Tobin Bronze Rod.

Maintenance men everywhere are taking advantage of the salvage and repair opportunities offered by Anaconda Welding Rods, such as Tobin Bronze, "997" Low Fuming and others.

Their experience is making the slogan "Don't scrap it... Bronze weld it", an order of the day in wartime industrial plants. Publication B-13 contains suggested welding procedures and examples of savings in repair time and expense. Write for a copy. 45106

*Reg. U. S. Pat. Off.

ANACONDA

Anaconda Bronze Welding Rods

THE AMERICAN BRASS COMPANY—General Offices: Waterbury 88, Connecticut

Subsidiary of Anaconda Copper Mining Company—In Canada: ANACONDA AMERICAN BRASS LTD., *New Toronto, Ont.*

BUY WAR BONDS... Keep buying them, Buy them for Keeps

LINDE TO HOLD PRESSURE-WELDING SCHOOL

Beginning January 15 The Linde Air Products Co. with the cooperation of Pressure Weld Co., Houston, Tex., will conduct a training course for the purpose of giving detailed instructions in the proper procedure to be used in pressure-welding overland pipe lines. The school will be held at the warehouses and plant of Pressure Weld Co., Houston, under the direction of Linde service operator H. A. Yost, assisted by members of the Pressure Weld Co. field force. A welding clamp of the type used in the field, complete with the necessary auxiliary equipment, will be used to train the men under actual field conditions. Men are trained in small groups to give an opportunity for individual instruction. Each man who attends the school is provided with a specially prepared illustrated reference manual of the subject and, because he will actually operate the pressure-welding equipment, the trainee should bring work clothes with him. The average training period is about two days.

More than 50 welding operators, pipeline inspectors and other interested field men representing 30 companies were instructed at a similar school held last fall. Oil companies, gas companies and pipeline contractors in the vicinity of Houston sent selected personnel to the school for training. Men came as far as 500 miles to attend.

Complete information on the pressure-welding school may be obtained from the Houston Office of The Linde Air Products Co., 6119 Harrisburg Blvd., Houston 11, Tex.

The Equipment Used in the Training Program Is Identical with That Actually Used in the Field

National

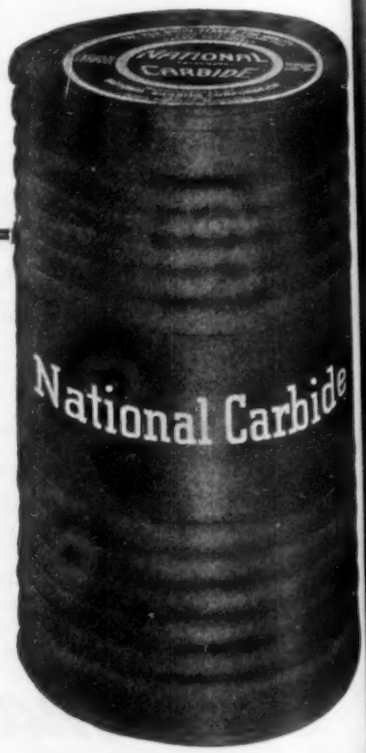
Carbide

IN THE RED DRUM

EFFICIENT

ECONOMICAL

DEPENDABLE



FOR WELDING and CUTTING

Use National Carbide in the Red Drum

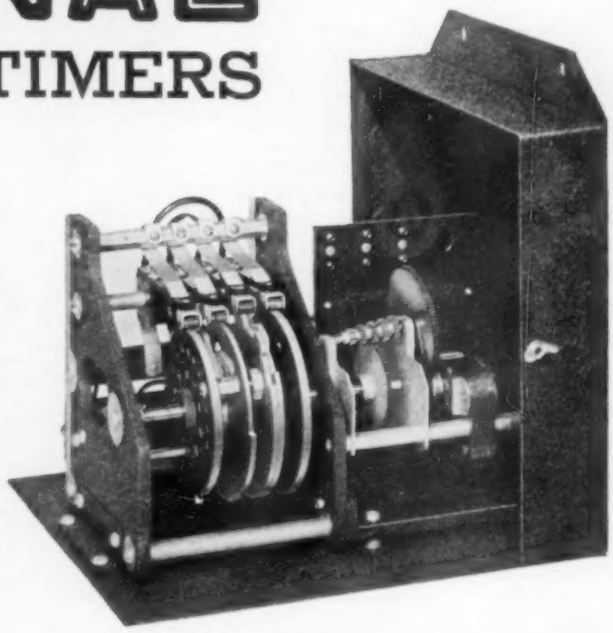
60 E. 42nd St. NATIONAL CARBIDE CORPORATION New York, N. Y.

For Welding Heavy Metals

NATIONAL

PULSATION WELD TIMERS

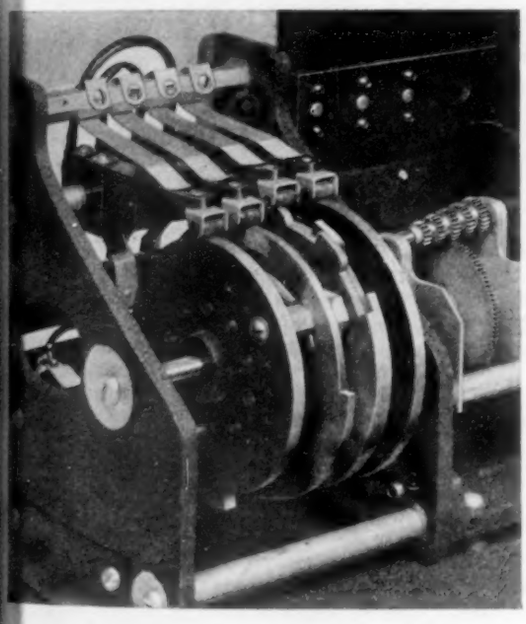
MODEL
1549 P



- *Pump the Heat Into Weld*
- *Reduce Flashing, and Burns*
- *Make Cleaner Welds*

Presenting NATIONAL'S new 1945 Interrupter-timers—five improved models specially designed for fast, thorough welding of heavy metals. These are the same fine quality type of timers used by industry for many years to handle the tough, heavy jobs. They also control and time the pressure to Electrodes through a Solenoid Valve. Precision-built by NATIONAL—America's foremost maker of welding controls.

It is being used more and more—INTERRUPTED WELDING—for Stronger, Uniform Weld Joints



Here's a close-up view of the heart of the new 1945 National Type 1549P Timer. With this fine, precision timer, interrupted welding of heavy metals can be handled properly, and in volume. Heavy metals cannot be fully welded by one charge of current. It has been well established that pumping the heat into the weld two, three or more times, while the pressure to electrodes is held, produces a superior weld-joint. Also, it can be done with less KVA capacity. The 'off' interval between 'on' time *must* be short—not much over one cycle, otherwise metal will cool and form a crust that must be heated all over again. 5 cycles 'on', 1 cycle 'off', repeated 4 times, will weld 2 pieces of $\frac{3}{16}$" metal perfectly, with 50 KVA applied. It reduces flashing and burns to a minimum. Even light-gage steel sheets are frequently welded with 2 interruptions, instead of a single spot, to produce a cleaner weld, without discoloration.

Get the facts about Interrupted Welding with National Repeat Timers—also identified as NEMA Type 9B PULSATION SEQUENCE CONTROL

NATIONAL TIME & SIGNAL CORPORATION

600 E. MILWAUKEE AVENUE DETROIT 2, MICHIGAN

Welding Developments of 1944*

IF A jeep can get there, so can a welder; and the result is that Army engineers can now make emergency repairs on tanks, trucks and other war equipment right up in the front line in Europe, or along jungle paths in the Pacific. Consisting of a standard Army jeep with a modified arc welder bolted to the floor in place of the right-front seat, the welder-jeep, has seen plenty of action. Light in weight, compact, highly mobile and extremely maneuverable, it can go places where heavier maintenance vehicles find the trails impassable. Also, it can be loaded aboard a transport plane for use in airborne operations.

Driven by a V-belt on a power take-off from the jeep's engine, it is ready for operation as soon as the vehicle is stopped. The governor, easily disengaged by a hand-operated clutch to permit normal operation of the jeep, maintains proper engine speed. Any welding current from 40 to 250 amp. is obtainable, and electrodes up to and including 1/4 in. diameter are accommodated.

Just as the Army has its welder-jeep, the Navy has its particular equipment. Installation was made in a Navy LVT (Water Buffalo) combat vehicle of a jeep-type engine, a welder and the miscellaneous accessories. Such an equipment is of inestimable value in salvaging damaged equipment since the LVT vehicle is built for island-landing operations.

Welding Broken Tank Tread on the Battlefield with the Army's Welder-jeep

Shipboard Welders—Through the Hatchway

A 200-amp. d.-c. arc welder of special design was developed for shipboard use. Requirements were that it pass through the 16- by 16-in. hatchway, be as light as possible in weight, and be constructed to withstand high impact shock. Such a welder with a d.-c. motor weighs 450 lb. as compared to approximately 1000 lb. for a standard welder of the same output. A.-c. motor-drive was also made available.

Gas-shielded Arc Welding—for Light Metals

The application of both manual and automatic gas-shielded arc welding was extended considerably during the year, especially in welding aluminum and magnesium, and stainless steel. This type of welding—in which a relatively permanent electrode such as carbon or tungsten is surrounded by a stream or envelope of inert gas—is expected to be of most interest in the fabrication of wrought aluminum and magnesium and the repair of castings in these metals. Welding stainless steels, particularly in the thinner gages, and making electrical joints in copper are still other uses. Magnesium alloys can be welded readily with a helium-shielded arc, using standard d.-c. power sources. Aluminum alloys can be welded readily without flux, with an argon-shielded arc supplied with alternating current from a special power unit.

Welding Spotlight—No "Pecking"

An arc-welding spotlight was developed to enable welding operators to see their work clearly through the welding lens of their helmets before striking the arc. The operator can thereby strike the arc exactly where he wants it, without "pecking" or "feeling" around. Time is saved and spoilage avoided.

Electrodes—for Aircraft Steels

A high-tensile electrode was developed to meet an urgent need of the aircraft industry for an electrode which would produce a high-tensile deposit when welding the heavier thicknesses required for the larger bombers and transport planes. Arc stability is good over a reasonably wide arc-voltage range, making it easier for the operator to keep the arc in operation, avoid pop-out of the arc and maintain uniformity of deposit. The arc has sufficient force to keep the slag from crowding the weld metal when welding vertically downward, and the metal freezes quickly when welding overhead or vertically upward.

* This is one of the sections of General Electric's annual review of electrical developments published in the January 1945 issue of the *General Electric Review*.

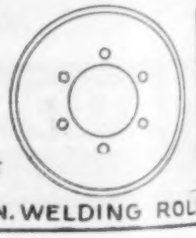
OFFSET HOLDER

"ELECTROLOY" for RESISTANCE WELDING

Butt
Flash
Spot
Seam
Projection

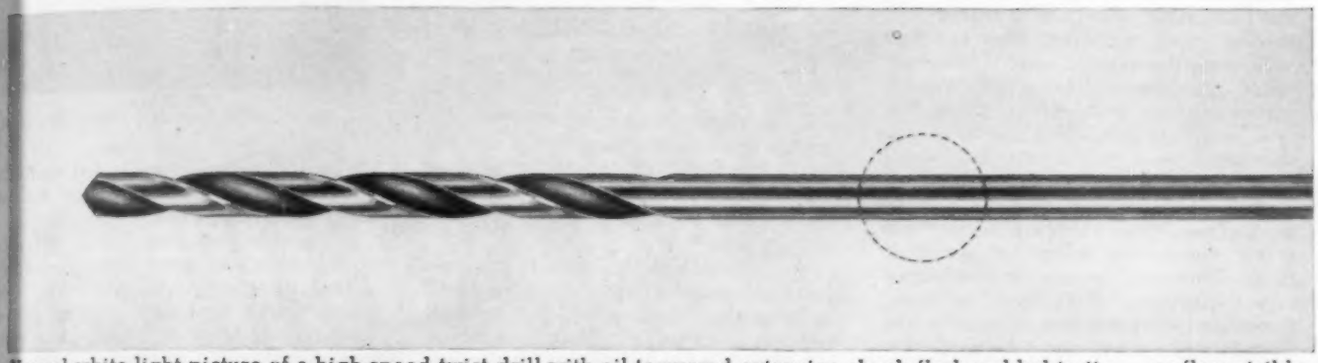
ELECTROLOY

Catalog and prices on request


WELDING ROLL

THE ELECTROLOY CO. INC. 1600 SEAVIEW AVE. BRIDGEPORT, CONN.

By Modern BLACK MAGIC



Normal white-light picture of a high-speed twist drill with oil-tempered extension shank flash-welded to it . . . no flaw visible.

ZYGLO*

Shows Up Flaws of Twist Drill Shanks in Darkness

Zyglo's unmistakable indication of defect caused by lack of fusion.

The best time to discard an imperfect flash-welded drill, like that illustrated above, is before it breaks in use—with possible injury to operator and probable damage to the part in process. This calls for 100% pre-service inspection of every weld—careful, accurate inspection by a method which *reveals clearly* what the unaided eye cannot see.

ZYGLO's brilliant fluorescent penetrant indications unfailingly locate *and show up* such dangerous defects in all welds...lack of fusion, cracks, etc.

ZYGLO Inspection, fast enough to keep step with production, may be adapted successfully to all types of welds—in both magnetic and non-magnetic metals.

Think about the possible application of ZYGLO in your production. Write for illustrated bulletin and full information.

**ZYGLO—The Trade Mark of Magnaflux Corporation applied to its equipment, material and methods for fluorescent penetrant inspection.*

MAGNAFLUX CORPORATION

MAGNAFLUX CORPORATION

5902 Northwest Highway, Chicago 31, Illinois

NEW YORK • DETROIT • DALLAS • LOS ANGELES • CLEVELAND • BIRMINGHAM

An improved electrode was produced for horizontal fillets and joints of all types in the flat position. It provides smooth, high-speed deposition of high-quality weld metal, meeting A.W.S. specifications, Classes E-6020 and E-6030.

Resistance Welding—for Special Jobs

Standard resistance-welding equipments continued through the year to find added applications of major importance in war production, but in addition there were various applications calling for special equipment. In one such case, involving the fabrication of helicopter blades from tubular steel, mild-steel clips are spot welded to the tubular steel. Since the steel is air hardenable, a new control equipment was required to temper the weld, reducing brittleness and increasing ductility.

A new low-capacity capacitor-discharge control was developed, utilizing a small bank of capacitors which are charged to a preset voltage by means of electronic tubes. Sufficient energy is discharged into the primary of the welding transformer to induce suitable currents in the secondary or welding circuit for spot welding thin-gage materials as used in electronic tube manufacture.

A complement of the series-capacitor control was developed, utilizing shunt capacitors for power-factor correction, for use in those plants having only limited power supply for resistance welders. Used with a bank of capacitors, the control connects the capicators to the primary circuit of the welding transformer at the correct point with reference to power-supply voltage so as to avoid the heavy surge current which would occur otherwise. The series-capacitor arrangement is generally preferred for power-factor correction in new applications, but this control, together with the shunt capacitor, is of value in correcting existing installations.

REDUCING AIR-FLOW DRAG ON AIRPLANES

Even the tiniest projection from the surface of an airplane is sufficient obstacle to the free flow of air to interfere to some extent with speed and, therefore, to increase fuel consumption per distance traveled.

This sort of drag on air flow has been greatly lessened by modern improvement in the method of fastening the skin of an airplane to its frame. Instead of rivets, resistance welding is employed as the connecting medium, thus eliminating rivet heads.

As clearly shown in the accompanying illustration, the surface is left perfectly smooth, allowing unobstructed flow of air over the surface of the craft.

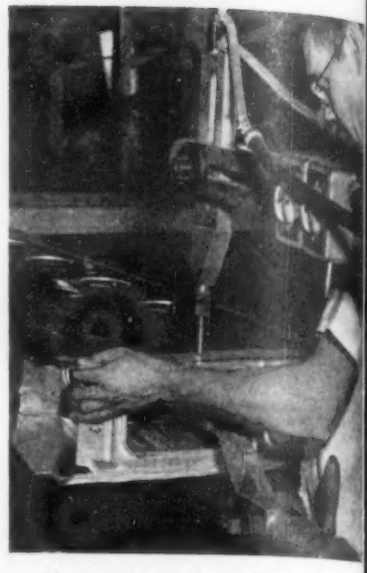


Photo courtesy Resistance Welder Mfr. Ass'n

But other important advantages accruing from the newer method are reported by Fleetwings, Inc., division of Kaiser Cargo, Inc., pioneers in the use of resistance welding in metal plane construction.

For example, fittings can be made smaller and lighter, because of the close pitch permitted in spot welds.

PRACTICAL DESIGN OF WELDED STEEL STRUCTURES

by H. M. Priest

An up-to-date book of 150 pages copiously illustrated with charts and photos giving practical design information and procedures for the design of welded steel structures. Price $1.00. Bound in cloth covers.

AMERICAN WELDING SOCIETY,

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Time Counts—
Gas cut and Weld with

Shawinigan Carbide

SHAWINIGAN

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EMPIRE STATE BUILDING, NEW YORK 1, N.Y.

Buy "Proven Fluxes" with Years of Guaranteed Satisfaction behind them

The Trade-Name is "ANTI-BORAX"

Ask for Them *Unequalled for Quality*

A Flux for every metal: Cast Iron Welding Flux No. 1; Brazing Flux No. 2; Braz-Cast Flux No. 4 for bronze-welding cast iron; "ABC" Aluminum Flux No. 8 for sheet Aluminum and all alloys of Aluminum; Stainless Steel Flux No. 9; Silver Solder Brazing Flux No. 10; No. 16 Silver Solder Paste Flux.

ANTI-BORAX COMPOUND COMPANY
Fort Wayne, Indiana

NOW . . . RESISTANCE WELDING WITH AN

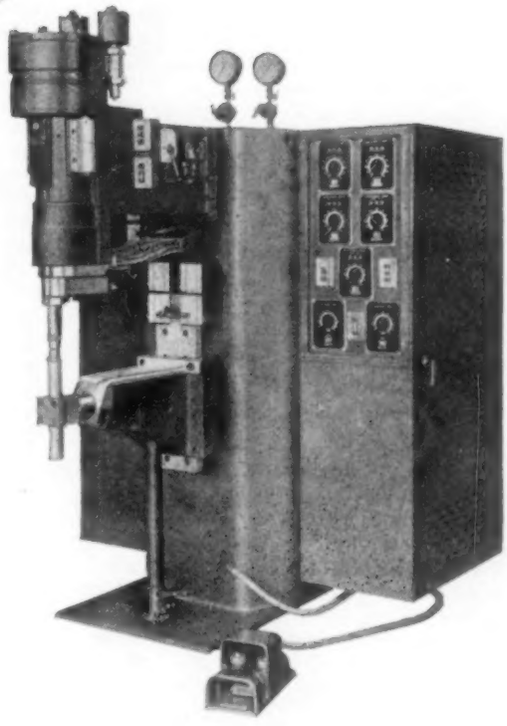
evenly balanced three-phase load . . .

"THREE-PHASE"

Resistance welding steel in heavy gauges places a high, periodic demand on the power supply. Conventional a.c. welders — designed for single phase — seriously unbalance the load, cause flicker in the line and often require expensive substation and distribution equipment.

Sciaky "THREE-PHASE" welders employ a principle enabling them to take practically an equal amount of current from each phase of the power supply, thus operating on a ***balanced load.*** An ideal low frequency welding current is produced first by converting to d.c. then reconverting to an alternating impulse. This system also provides operation at high power factor (80 to 85%) and decreased actual power demand.

The Sciaky "THREE-PHASE" Welder illustrated is designed for high quality spot welding on mild and stainless steels and rusty and scaly stock in thicknesses from .032" to .312". Rating is 100 KVA at 50% duty cycle, operating at 85% power factor. Speed on two thicknesses of .062" mild steel is 90 spots per minute. Special features include Variable Pressure with a maximum pressure of 5,000 lbs., and adjustable Preheating Current.



Write for bulletin 204-A describing fully the principle of the Sciaky "THREE-PHASE".

SCIAKY BROS.

Manufacturers of a Complete Line of AC and DC Electric Resistance Welding Machines

4915 West 67th Street **Chicago 38, Illinois**

Offices in Detroit, Los Angeles, Washington, Cleveland and New York

Representatives in Principal Cities

In England: Sciaky Electric Welding Machines, Ltd., London

In France: Sciaky S. A., 13, 15 Rue Charles Fournier, Paris

SECTION ACTIVITIES

BIRMINGHAM

The January meeting of the Birmingham Section was held on the 4th in the Auditorium of the Alabama Power Building. Mr. Milton Bowers, Proprietor of Milton Bowers Welding Co., Memphis, Tenn., outlined his experience as a job welder over the past twenty-five years. Mr. John C. Thieme, Field Engineer, Eutectic Welding Alloys Co., New York, N. Y., presented his experience on the use of welding as a solution to maintenance, repair and salvage problems. A film, "The Use of the Electric Arc in the Maintenance, Construction and Repair of Cutting Tools," was shown through the courtesy of the Welding Equipment and Supply Co., Detroit, Mich.

The following are the programs of meetings starting with the March meeting.

Thursday, March 1st—"Distortion in Welded Structures and Its Correction." Prevention—Design, Jigs, Welding Procedure, Setup; Causes—Avoidable and Unavoidable; Correction—Flame Shrinking, Mechanical, Furnace.

Thursday, April 5th—"Shipyard Welding." Hull Construction (Subassembly—Erection); Auxiliary Welding—Piping, Stacks, Thermit, Rudders, Chain, King Posts; A Woman's Viewpoint; Ship Repair Welding.

Thursday, May 15th—Joint Meeting—American Society for Metals and AMERICAN WELDING SOCIETY. "Metallurgical Aspects of Arc Welding."

All Meetings at 8:00 P.M. in the Alabama Power Building Auditorium.

CHICAGO

J. Wesley Cable of the Induction Heating Corp., discussed "Induction Heating for Soldering and Brazing" at the December 15th meeting held in the Peoples Gas Auditorium. Mr. Cable discussed induction heating which is playing an increasingly more important part in brazing and soldering applications. A Pre-Meeting Movie, "Birth of the B-29," shown through the courtesy of the War Department, showed some of the revolutionary mechanical features of this giant aircraft. "Ski Revels," which combined beautiful winter scenes with skilled action at high speeds, and "Jack Frost," a technicolor comedy, were also shown.

CINCINNATI

A joint meeting and plant visitation at Cincinnati Milling Machine Co. was held on Thursday, January 11th, by the American Society for Metals and the AMERICAN WELDING SOCIETY. From four to six o'clock in the afternoon the members visited the welding shop, the machine shop and the heat treat department. Dinner followed in the cafeteria, after which the evening meeting was held. Frank McGuire, Division Service Engineer, The Linde Air Products Co., gave an illustrated talk on "Flame Hardening."

CLEVELAND

A revised City Code of Structural Welding will very shortly be presented to the Cleveland City Council and is being sponsored by a number of technical societies in Cleveland.

As a part of the plan to interest many different technical societies in this Welding Code, the Cleveland Section was very fortunate in being able to have Mr. H. W. Lawson, engineer for the Bethlehem Steel Co., speak on January 10th on "Welding in Modern Building Construction."

Members of the various architect, civil engineer, and professional engineers societies heard Mr. Lawson give an excellent, down-to-earth discussion of many phases of welded structures, with particular reference to the design details which he has developed.

Mr. Lawson is well known in the eastern part of the United States and gave an excellent paper on a similar subject at the National Convention in Cleveland. His work along structural welding lines has been so outstanding that it was felt desirable to have him return to Cleveland.

At dinner Miss Esther Mullin, director of women's activities at Radio Station WGAR, and a member of the acting staff at the Cleveland Playhouse and instructor in drama at Western Reserve University, gave an interesting talk and monolog.

The Cleveland Section Educational Course given during the last half of 1944 was so successful that it is being continued during 1945. No charge is being made for these educational courses at the present time, which include lectures and plant trips into the factories of various manufacturing members of the Cleveland Section.

DETROIT

Power-line problems growing out of welding installations were described in interesting detail at the first 1945 meeting, held on January 5th, of the Detroit Section, by L. W. Clark of the Detroit Edison Co. The meeting was held in the Edison building auditorium.

Most welding installation problems, in so far as the power source is concerned, grow out of lamp flicker, Mr. Clark indicated. The amount of flicker developing in a line can be reduced, he said, by locating the transformer close to the machine, and by spacing the conductors closer together. Such methods reduce voltage drop. Storage battery and stored energy welders, he said, impose no problem in equalizing the line load. As to other types of welders, he estimated that a conventional single-phase welding machine imposed the heaviest load, a three-phase machine about two-thirds of the single-phase's, while a single-phase machine with series capacitors imposed about 40% of the line load of the conventional installation.

It was announced that the March 14th meeting would be held jointly with the Society for Advancement of Management, with James F. Lincoln, of The Lincoln Electric Co., the featured speaker.

The following is the program for the next couple of meetings:

March 2nd—Ford Night.

March 14th—Joint Meeting with Society for Advancement of Management. Speaker, James F. Lincoln, The Lincoln Electric Co.

April 6th—"Induction Heating," J. W. Cable, Induction Heating Corp.

May 4th—Second Annual Welding Conference. Technical Sessions—Rackham Memorial Bldg. Dinner and Evening Meeting—Wardell-Sheraton Hotel.

HARTFORD

The first regular meeting of the Hartford Section was held at the University Club of Hartford on Friday, December 8th, and although the weather was extremely bad, there were 38 people present.

The following officers were unanimously elected: *Chairman*, John W. Mortimer, Whitlock Mfg. Co., Hartford; *Vice-Chairman*, Shaw Taylor; *Secretary*, R. H. Florian, Trumbull Elec. Mfg. Co., Plainville, Conn.; *Treasurer*, Louis C. Koch; *Program Chairman*, Wm. D. Halsey; *Membership Chairman*, Fred J. Giroux.

Each of the officers said a few words to the assembly.

The meeting was then turned over to Mr. A. M. Setapen of Handy & Harman, who presented a very interesting talk on the application and use of low-temperature silver-brazing alloys. This talk was supplemented by lantern slides and followed by an actual demonstration of torch brazing.

LOS ANGELES

Because of his transfer to Chicago, David Bisbee had to resign as Chairman of the Los Angeles Section. Charles Babbitt, Vice-Chairman, was appointed Chairman. Clifford Sommarstrom was appointed Vice-Chairman.

LOUISVILLE

The Louisville Engineering and Scientific Societies' Council published its first edition of "The Louisville Engineer and Scientist" in December 1944. This is an

HERE IS OUR COMPLETE RACO LINE

MILD STEEL ELECTRODES

Type—RACO	7, All Position, Reversed Polarity	AWS E-6010
"	11, All Position, A. C.	AWS E-6011
"	8, General Purpose, Poor Fit-up	AWS E-6012
"	13, General Purpose, Light Gauge	AWS E-6013
"	20, Horizontal Fillets	AWS E-6020
"	5, Deep Grooves	AWS E-6030

HIGH TENSILE STEEL ELECTRODES

Type—RACO	74, All Position, Reversed Polarity	AWS E-7010
"	64, Horizontal Fillets	AWS E-7020

STAINLESS STEEL ELECTRODES

Type—RACOLLOY	18-8, Unstabilized	Type 308
"	18-8Cb, Stabilized	Type 347
"	18-8(1.5% Mo)	Type 316
"	18-12(2-3% Mo)	Type 317
"	18-12(3-4% Mo)	Type 307
"	19-9, For Welding air-hardening steels	Type 309
"	25-12, Unstabilized	Type 310
"	25-12Cb, Stabilized	
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admirable and timely effort to coordinate the aims and activities of some ten groups whose kindred subjects dovetail in many respects. Conflicting meeting dates and procedures as to programs will be one of the items to be coordinated.

The annual business meeting of the Louisville Section was held on December 12th, with those present reviewing the year's activities. A color sound film, "Eighteenth Century Life in Williamsburg, Virginia" courtesy Eastman Kodak Co., was shown and found educational, enlightening and entertaining.

MILWAUKEE

The meeting place of the Milwaukee Section is at the Ambassador Hotel on the last Friday of the month, except when that day falls on a holiday or close to one. The December 15th meeting was, as usual, a dinner meeting. After-dinner talk and movie were presented by Lt. Jay G. Schadt, navigator on a B-17 in Europe. The movie was on "Air Corps Matériel Equipment." A "Symposium on Tool and Die Repair by Welding" had as the main speakers Mr. J. Welch of the Cutler-Hammer Co. and Mr. H. E. Bailie of the Nordberg Mfg. Co.

NEW YORK

The New York Section held a joint meeting with the Metropolitan Chapter of the American Foundrymen's Association and the New York Chapter of the American Society for Metals at the Building Trades Club on Monday, January 8th. T. D. Parker, Climax Molybdenum Co., New York, presided as Technical Chairman.

The speaker for the evening was Norman L. Mochel, Manager of Metallurgical Engineering, Westinghouse Electric & Mfg. Co., Philadelphia, Pa., who spoke on the subject, "Shall It Be: Cast? Forged? or Welded?" He described the factors to be considered in selecting castings, forgings or weldments for construction or fabrication of various types of industrial equipment. His talk explained when each of these methods should be used and showed how casting, forging and welding can work together rather than compete with each other. Mr. Mochel also showed that many structures can advantageously combine two or more fabricating methods. His talk was well illustrated by numerous lantern slides.

NORTHWEST

"Welding and Problems Associated with Welding" was the subject of T. McLean Jasper's address at the January 9th meeting. Mr. Jasper is Technical and Research Director, General American Transportation Corp., Chicago.

OKLAHOMA CITY

The regular December meeting of the Oklahoma City Section was held on December 14th at 7:30 P.M. at the Black, Sivalls & Bryson, Inc., plant in Oklahoma City.

The program consisted of a practical demonstration of the application of low melting point alloys by M. C. Robbins, Service Engineer, Handy & Harman Co., Chicago, Ill. Of particular interest was the joining of copper, steel and alloy metals, as well as dissimilar metals, by methods developed by the Handy & Harman Co.

The program was followed by a plant tour of Black, Sivalls & Bryson, Inc., which enabled those attending to see the plant in full operation.

Oklahoma City Section has added 37 new members since the beginning of the 1944–45 season.

PHILADELPHIA

The Philadelphia Section Education Committee under the chairmanship of Wm. B. Brooks is working with the Philadelphia Section of the American Society for Metals to re-establish the course in Welding Metallurgy given at Temple University last year. Plans are being made to run this course from 15 to 20 weeks starting about the middle of February. Members of both societies will act as instructors and an enrollment of approximately 100 students is anticipated.

The Structural Committee headed by W. F. Carson is working actively with the city officials who are planning a revision of the Building Code. The committee seems to have the utmost confidence in Mr. Carson and it is very probable that they will accept many of his suggestions.

A. Amirikian, of the Bureau of Yards and Docks, U. S. N. was the speaker for the November 20th meeting, and he gave an excellent talk on Structural Engineering. This meeting was attended by members of the American Institute of Architects and the American Society of Civil Engineers.

At the December 18th meeting T. D. Radcliffe of the Standard Oil Co. of California outlined the many uses of clad and stainless steels in oil refineries. Representatives from all of the refineries in the area were present and a lively discussion followed Mr. Radcliffe's talk.

PITTSBURGH

The following are the future meeting dates, speakers and subjects to be discussed before the Pittsburgh Section:

February 21—"Welding of Copper and Copper Alloys," John J. Vreeland, Metallurgical Engineer, Sales Promotion Div., Chase Brass & Copper Co., Waterbury, Conn.

March 21st—"Steel Castings—Their Use in Weldments," E. J. Wellauer, Supervisor, Research & Metallurgy, The Falk Corp., Milwaukee, Wis.

April 27th—Eighth Annual Tri-State Convention. "Welding in the Post-War World," T. B. Jefferson, Editor, *The Welding Engineer*, Chicago, Ill.

Each meeting is preceded by a Question and Answer Period conducted by L. C. Bibber of the Carnegie-Illinois Steel Corp.

ROCHESTER

The January 4th meeting of the Rochester Section held in Lower Strong Auditorium, University of Rochester, was addressed by D. H. Corey, Welding Engineer with the Detroit Edison Co. His subject was "Welding and Stress Relieving of High-Pressure Piping Systems."

His "brassiere" talk covering the high spots of high-pressure welding proved very interesting to the members and guests that were present. With the use of slides, which, by the way, were remarkably clear, he explained the types of joints and welding procedures that are used in high-pressure pipe welding. His discussion of preheating and stress relieving, and the equipment that can be used for this work, was particularly interesting. For over an hour, after his talk, he was kept busy answering questions. All in the audience felt well repaid for their

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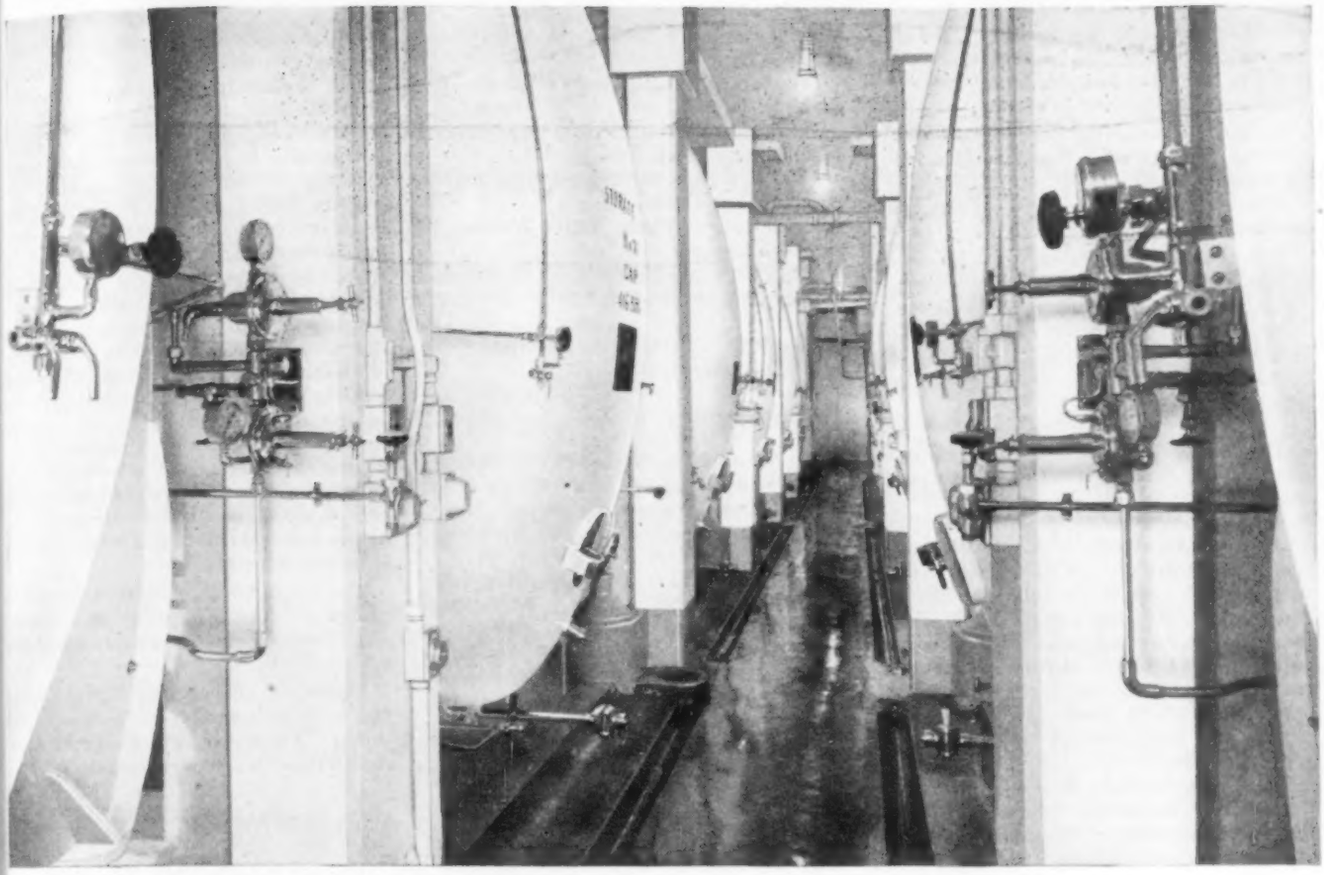

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efforts in attending the meeting. Due to the bad storm that has covered this area and the almost impassable roads, the attendence was smaller than usual.

An executive meeting was held Monday evening, January 8th. The bowling party on January 13th and the social evening planned for May were given special attention.

The February meeting will be addressed by George F. Wolfe of Dravo Corp. His subject will be "Production Line Assembly Methods as Applied to Ship Construction."

ST. LOUIS

The St. Louis Section held their regular meeting on Friday, December 8th, at the Engineers' Club Auditorium. The speaker for the evening, J. A. Hudson of The Linde Air Products Co., spoke on some new developments in oxyacetylene cutting. Mr. Hudson's talk was illustrated with slides and a short movie. His treatment of the subject included manual cutting and machine cutting from the simplest type of machine to the most elaborate. The short movie illustrated the cutting of a heavy casting riser weighing approximately 10 tons. The pre-meeting movie was a war film, entitled "Birth of the B-29." Following the meeting, refreshments were served in the Club Recreation Room.

TOLEDO

The December meeting was held on the 19th at the Macomber Vocational School. A half-hour "Problem Period" was held for the first time and "Problem Chairman" Sam Snell did a good job. The speaker of the evening, Frank E. Thompson, Jr., Salvage Engineer of the Thompson Engineering Co., Grand Rapids, Mich., gave an exceedingly realistic and most interesting talk on "Salvage at Pearl Harbor after December 7, 1941." A film, "Return to Guam," was shown.

Meetings for the remainder of the season are as follows:

February 19th—"Electric Resistance Welding," by Mario Sciaky.

March 19th—"Metallizing or Metal Spraying," by David C. Boltz.

April 16th—"Flash Butt Welding," by W. S. Evans.

May 21st—"Welding and Problems Associated with Welding," by T. McLean Jasper.

June 18th—"Welding as It Effects Design," by Leslie McPhee.

WASHINGTON, D. C.

The Washington Section of the AMERICAN WELDING SOCIETY was host December 13th at the seventh annual joint meeting of that society and the Washington Chapter of the A. S. M.

The guest speaker for the evening was Norman L. Mochel, Manager, Metallurgical Engineering, Westinghouse Electric and Mfg. Co., whose theme, "Weldments versus Castings versus Forgings," was presented with the viewpoint of a specialist whose chief interest was heavy equipment. Mr. Mochel spoke of the growing feeling of confidence in welding during the war and pointed out that although much progress naturally was made at the expense of casting and forging these latter two methods of fabrication had not suffered in production because of the big job they had to do in the war.

In discussing the black marks against all three fabrication methods, such as flakes and fissures in forgings, defective castings, ship failures and the like, the speaker suggested that a broad viewpoint was needed since all branches were weighted with tremendous production schedules. The superb contributions of all branches since the war were mentioned in some detail. Centrifugal line castings were cited as a progressive step which after the war would compete with forging. Electrical machinery frames long made by casting would be largely welded structures later on while larger machinery castings would be eliminated in preference to welding. Locomotive beds should continue to be cast due to the quantity required, the speaker said. Ship shaftings of alloy steels have long been a forged product but if cracks are prevalent and are accepted by inspectors of the forging field, Mr. Mochel stated, the method takes a downward step. Interesting slides were shown by the speaker in taking his audience on visits into foundries, forge shops and welding shops, while he discussed his subject. Merchant ships, turbines, central stations of power houses, propulsion equipment, condensers and gear rings were among the items presented pictorially. The use of all three methods of fabrication in one unit was shown in a large structure in marine service.

The use of precision casting in turbine blades and for other parts was also mentioned as important steps forward in this field.

Following the discussion period a sound film, "New Horizons in Welding," was shown. The serving of refreshments concluded the well-attended meeting.

YORK-CENTRAL PA.

The regular monthly meeting of the York-Central Pennsylvania Section was held on December 13th. A sound movie in technicolor, "Development of Steam Power," showing installations and interior of furnaces, also Animated Drawings were shown. Mr. E. B. Van Sant, Superintendent of the Badenhauser Corp., Division of the Riley Stoker Corp., was the speaker of the evening. His subject, "Welding for High Pressure," covered such features as heavy plates, construction, high-pressure boilers, superheaters up to 1800-lb. pressure, 1,000,000 lb. steam per hour.

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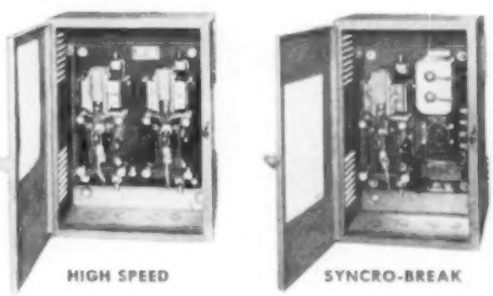

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MacFarlane, William Ian (B), MacFarlane Engineering Co. Ltd., Netherlee Rd., Cathcart, Glasgow 54, Scotland.
Molins Andre's (B), San Salvador, Central America.
Schunck, Joseph J. (B), 1714 Chicago Ave., Box 3228, Orlando, Fla.
Wilson, C. G. (B), 4409 Druid Lane, Dallas 5, Texas.

Members Reclassified During Month of December

CLEVELAND

Barr, Glenn S. (from D to C), Avon Lake, Ohio.

HARTFORD

Koch, L. C. (from D to C), The Fafnir Bearing Co., New Britain, Conn.

NEW JERSEY

Albright, Albert R. (from D to C), 5 Colin Kelly St., Cranford, N. J.

NEW YORK

Simons, Alexander (from D to C), 625 Howard Ave., Brooklyn, N. Y.

PASCAGOULA

Bowen, W. B. (from C to B), The Ingalls Shipbldg. Corp., P. O. Box 149, Pascagoula, Miss.

PHILADELPHIA

Gorgas, F. Y. (from D to C), 4030 Hartel Ave., Philadelphia 36, Pa.

NOT IN SECTIONS

Broughton, Wm. H. (from D to C), 325–9th St., Ashland, Ky.
Kyler, Donald (from C to B), 1216 Leonard Ave., Elkhart, Ind.

NEW BY-LAWS

The Board of Directors at its meeting on December 15, 1944, adopted a revised set of By-Laws with all suggested revisions incorporated.

Article XX of the By-Laws—"Amendments"—specifies that after approval by the Board of Directors, amendments shall be considered temporary and then shall be published in THE WELDING JOURNAL, and not less than 30 days later shall be submitted to the membership for letter ballot. The amendments shall be adopted at the expiration of 60 days after mailing the ballots unless rejected by at least 20% of the voting membership.

In accordance with the above requirement, the By-Laws are published in this issue of the JOURNAL.

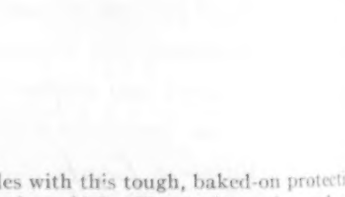
NAVAL ARCHITECTS

At the 52nd Annual Meeting of The Society of Naval Architects and Marine Engineers, Mr. William S. Newell was elected president of the Society for a term of two years, beginning January 1, 1945.

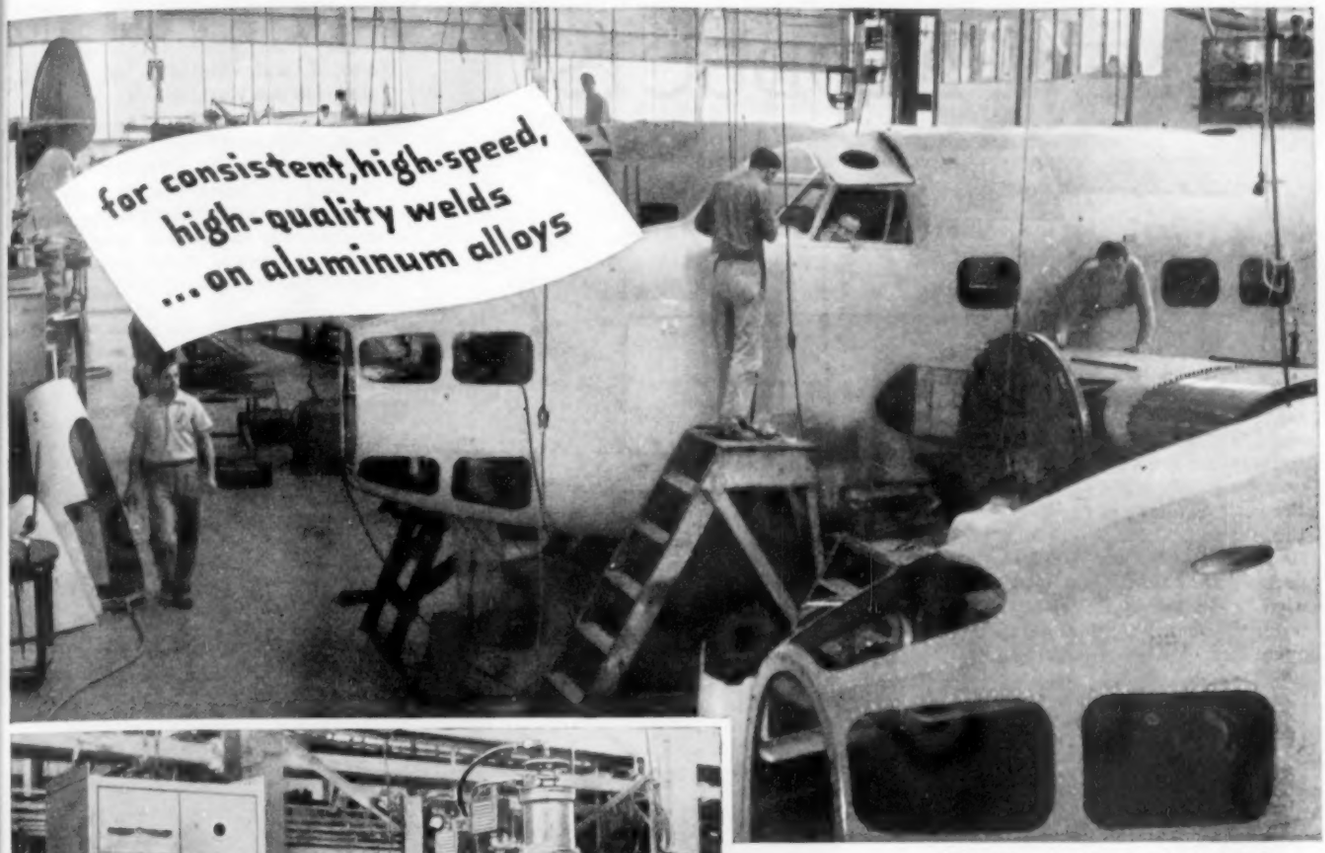
COVER GLASSES FOR WELDING SHIELDS

IPCO Processed Cover Glasses are regular glasses (2 x 4 1/4 in.) that have been treated with a protective coating to guard against heat breakage and damage from metal spatter.

They are completely covered on both sides with this tough, baked-on protective coating which will not pit, peel or rub off.



Saving many minutes, per worker, each day, otherwise required in replacing broken or pitted glasses, their economy is soon proved. Welders say they outlast eight to fifteen ordinary glasses. For further information, write Industrial Products Co., 2820 N. Fourth St., Philadelphia 33, Pa.



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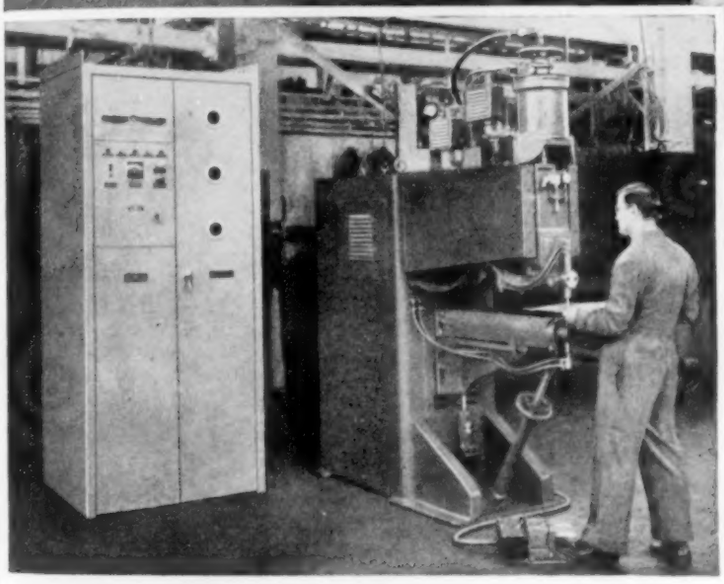

Use G-E CAPACITOR DISCHARGE CONTROL

---It provides accurate forge-pressure timing for your stored-energy welding machines

CONSISTENT values of current and timing, so vital to uniform, high-quality, aluminum-alloy welds, are insured when your stored-energy welding machines are equipped with this G-E control. Experience proves that required welding energy is reduced and weld quality improved by the accurate forge-pressure timing provided by this control.

Because of its low demand kva, this control permits the use of welders on distribution systems which, without it, might be overloaded. Also, because of its low demand on the line, which means less voltage drop, you can economically install your welding machines in the most favorable places on your production line, even though the machine may be some distance from incoming distribution transformers.

Good voltage regulation, afforded by the low demand kva, also lessens the possibility of light flicker, and limits interference with other welding equipment on the same circuit.

The arrangement and accessibility of all parts of the control make it easy to install and service.

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Please send a copy of your bulletin, "Capacitor-discharge control," No. GEA-3728, which describes the control, tells how it operates, and explains where it can be used most effectively.

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NEW PRODUCTS

The Society assumes no responsibility for the validity of claims in this Section

FACE SHIELD VISORS

A new snap-fast shield, developed by exhaustive research to save lost time, makes possible visor replacement in 15 seconds. Perforations in the visor fit snugly over small lugs. Spring clamps at each end hold the visor firmly in place. For release, a turn of the fingers snaps out the old visor, and a new one is quickly slipped into position. This feature is especially desirable when face shields are used in flash welding, butt welding, spot welding, heavy grinding, and other operations.

The tough, noninflammable plastacele visor protects the head and neck. It fits snugly against the chest to prevent the entrance of flying particles from below. Quick adjustment means easy wearing for men and women.

CESCO's new shields are available in four styles—including one with open top headgear, one with half crown headgear and another with helmet-like top and bottom guards. There is also a choice of two visor thicknesses. Complete information is available from Chicago Eye Shield Co., 2300 Warren Blvd., Chicago 12, Ill.

WELDED TRUSSES

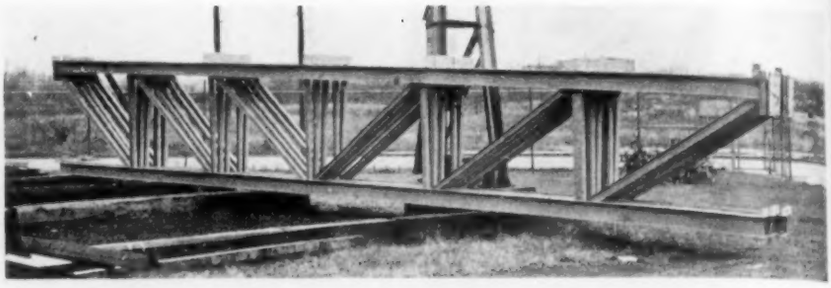
The Austin Co., engineers and builders, has adopted a new design for welded trusses of standard 50-, 60-, 70- and 80-ft. lengths, in which, for the first time, H-sections with their webs in a vertical plane are used throughout without gusset plates.

This truss is readily adaptable to different loadings by simply changing the weights of the beams used for the various truss members, according to J. K. Gannett, Austin vice-president and director of engineering. By keeping the depths of the individual members constant, these variations require no changes in shop details or fabricating jigs.

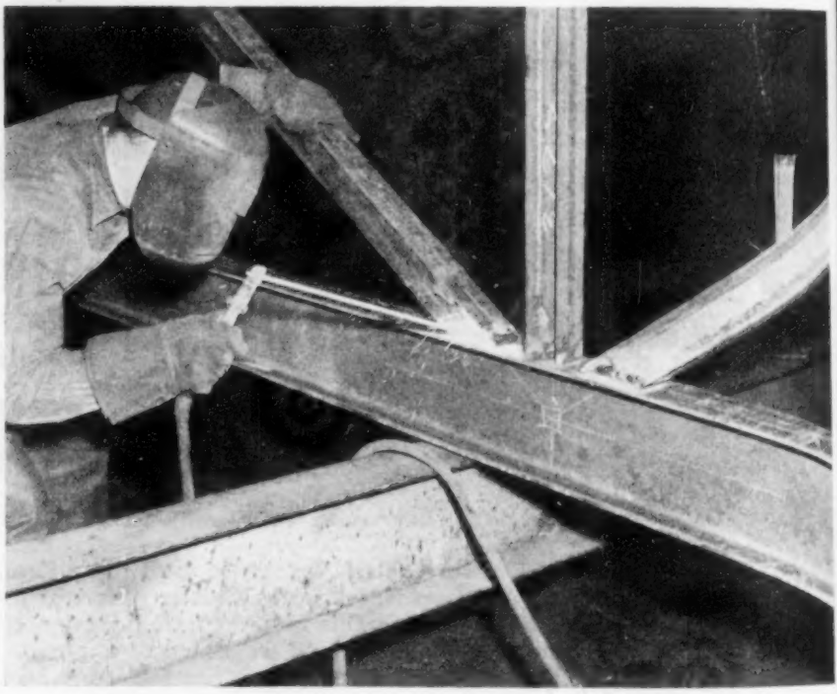
As the top chord is a wide flange beam, it can carry purlins at a variety of spacings without regard to panel points, and is also adaptable to continuous uniform loading. Similarly, the bottom chord can carry loads at any point and can be used, itself as a monorail.

A "natural" for welding, shop fabrication on a 50-ft. truss requires a total of 41 lineal ft. of fillet weld, all of which is accomplished by down welding. The H-sections are assembled in a jig, tack welded, and welding is completed with the truss in a vertical position.

Because it is fabricated completely from rolled members which are simply cut to desired lengths, no splitting, blocking, slotting or chipping is necessary. The only raw cut edges are closed by the welds, so that only the smooth, hard, rolled surfaces are exposed which gives the truss a maximum of corrosion resistance.



These 50-Ft. Trusses, in Which The Austin Company's New Design Employing H-Sections for All Members Was Used, Illustrate Their Clean-Cut Appearance and Simplicity. Adaptability of Such Trusses to the Installation of Monorails on the Lower Flanged of the Bottom Chord Is Made Apparent by the Preservation of the Full Beam Section from End to End



Fabricating One of the New H-Trusses, Which Consist Entirely of Rolled H-beams, and I-Beams, Merely Cut to Length and Fabricated by Connecting Vertical and Diagonal Members to the Top Flange of the Beam Forming the Bottom Chord, as Shown Here and to the Bottom Flange of the Top Chord

In full-size load tests on two 50-ft. trusses of this new design made at the fabricating shops of The Austin Co. in Cleveland more than a year ago, failure occurred under a load which was 253% of the design load, at which time an end vertical buckled. Despite the distortion of the truss when it collapsed, not a single welded connection failed.

The behavior of the truss under a heavy overload was impressive and is attributed in large part to the fact that the lines of action of all members lie in one plane, as well as to the concentricity and symmetry

New MUREX WALL CHART

A helpful guide to selecting the right Electrode for the job

This new chart, just off the press, contains a complete list of Murex Electrodes divided into four groups for quick reference; mild steel, special steels, stainless steels and hard surfacing. Electrodes are described according to AWS-ASTM class. Color identification, recommended current strengths, polarity, and physical properties are also given. In addition, there are brief descriptions of the electrodes' general characteristics and applications.

The chart is 24" x 37", printed in four colors.

Copies will be sent free to those who request them on their company letterhead.

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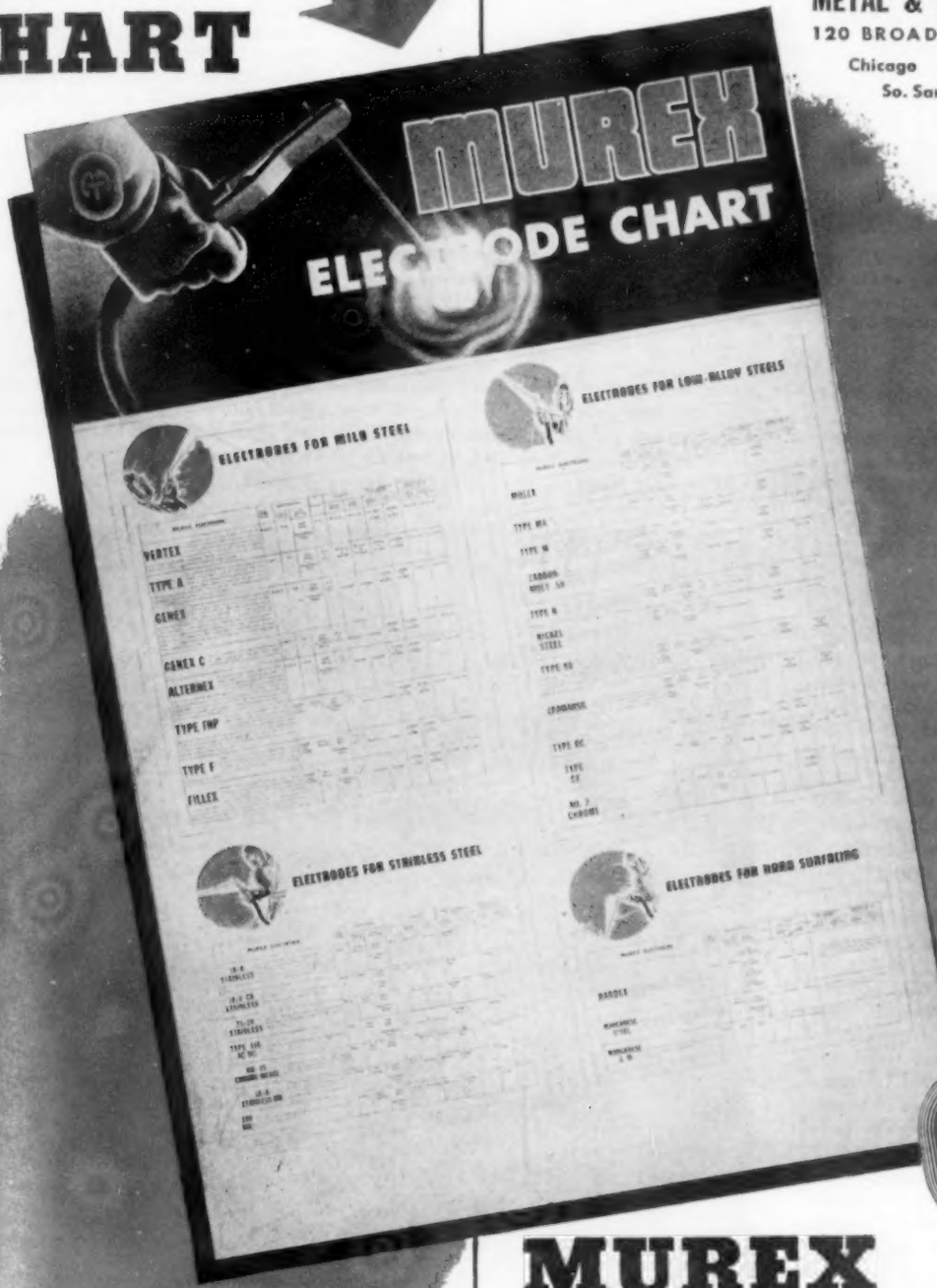
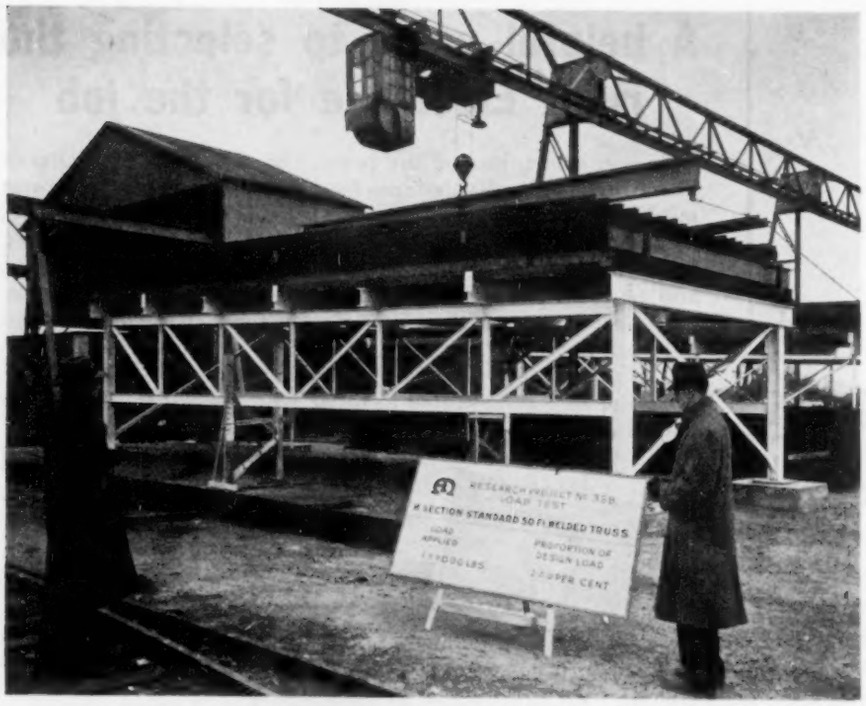
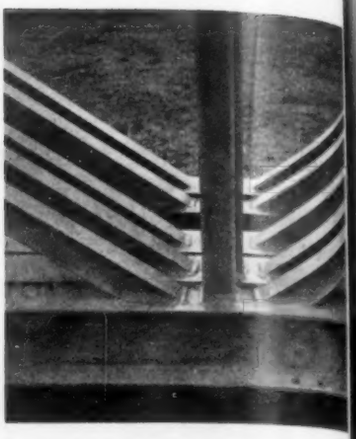


MUREX Electrodes



This View Shows the Manner in Which the New H-Trusses Are Tested to Destruction. Failure Occurred by Buckling of the Vertical Web-Member Seen on the Left, at a Time When the Super-Imposed Load Was 240,000 Lbs., Equal to 253% of the Design Load. In Spite of the Resulting Distortions, All the Welds Remained Intact



The Spendid Performance of the Trusses This Design Under a Heavy Over-Load Credited to the Fact That the Lines of Action of All Members Lie in One Plane, End Connections at Panel Points Are Not Only Concentric but Also Symmetrical

of the end connections of the truss members.

Following the tests, trusses conforming to the spans in widest use were designed and jigs set up for their manufacture. During the final quarter of 1944, trusses of this type were fabricated and shipped to plants in five widely separated localities, one of which involved an area of 100,000 sq. ft.

Experience in the field demonstrates that the new trusses are much stiffer than other welded trusses, and that they make steel erection work much safer. Structural iron workers, for instance, found that they could work much more easily on both top and bottom chords. This was particularly true of the bottom chord, where the flat upper flange provides a safer and more comfortable surface than the edge vertical edge found in most trusses. The flange not only provides an excellent walking surface but also a good seat for men while working on bolted, riveted or welded connections.

72 HARD FACING DEPOSITS ON ONE PIECE

Fabrication of the inspection cages shown in Fig. 1 involved an interesting application of hard facing. Each of the cages will hold 24 cylindrical parts for inspection. The body is made from a forged ring 17¾ in. outside diameter, 13 in. inside diameter and 3.2 in. thick. This ring is machined to the shape shown in Fig. 2, providing 24 equally spaced slots reamed on the top portion, and drilled below. These openings receive the parts to be inspected. It is important to preserve the dimensions of these openings by preventing wear and therefore a hard facing operation was prescribed for the areas indicated by the heavy shading in Fig. 3. The hard facing was done with Stoodite No. 63, applied by gas welding. This alloy flows freely and forms a smooth deposit which is extremely wear resistant, which characteristic determined its suitability for the particular purpose of maintaining the correct dimensions. The bottom of the cage was formed by welding on an annular disk cut to the shape shown in Fig. 4. The result of this construction is an inspection tool which made it possible to check dimensions of small parts very rapidly.

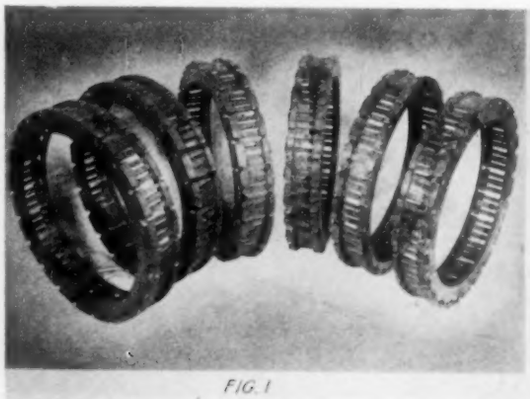


FIG. 1

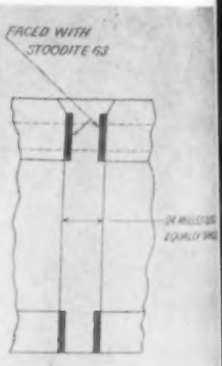


FIG. 3

FIG. 2

FIG. 4

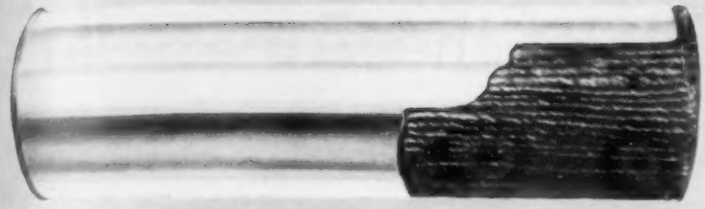
Photos by courtesy of C. E. Phillips & Co., Detroit, Mich.

Fig. 1—These Inspection Cages Were Machined from Steel Forgings and Hard Faced at Points of Wear

Fig. 2—Top View Showing Shape of Cage, and Points of Application of Hard Facing

Fig. 3—Sketch of Section of Slot. Heavy Area Indicates Location of Hard Facing Deposits

Fig. 4—Bottom View After Stiffening Ring Has Been Welded in Place



This centrifugally-cast bronze roller was found to have a defect. An overlay of Ampco-Trode 10 was deposited over the section, machined to finished size, and the piece salvaged.

End plates and shafts were welded to this bronze cylinder, saving considerable machining time and expense.

AMPCO-TRODE 10

COATED ALUMINUM BRONZE ELECTRODES

save time and money by performing 2 tough jobs

Salvaging defective castings

Here is a typical example of reclaiming costly bronze castings by overlaying the defective section with Ampco-Trode Coated Aluminum Bronze Electrodes. These electrodes deposit weld metal comparable in strength, ductility, and hardness with the various grades of cast Ampco Metal — giving you a grain structure closely resembling the parent metal. You save casting time, machining time, and metal. Use this proved method of reclaiming bronze and similar castings. Ampco field engineers, located in principal cities, are happy to help you with your welding and fabricating problems.

Providing low-cost fabrication

Another instance illustrating the savings that can be made with Ampco-Trode is the production of this cylindrical bronze roller with extended shaft. To eliminate the heavy cost of machining, the end plate and shaft were welded into position with Ampco-Trode 10, which in chemical and physical properties closely approaches the original casting. Five grades of Ampco-Trode are available to meet your specific needs. With tensile strength up to 100,000 psi and hardness to 300 Brinell, Ampco-Trode is recognized as ideal for such purposes as illustrated above and similar applications.

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Success of salvage and construction operations at Pearl Harbor, on the Normandie and in scores of liberated ports around the globe have rested largely on the technique of underwater cutting and welding that bid fair to play an important role in the peace-time world.

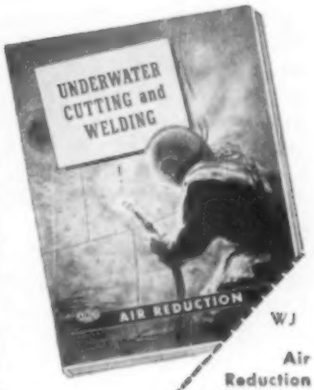
As a pioneer in flame cutting and welding, Air Reduction has been in the forefront in the development of underwater cutting equipment. The Airco Style 9116 Underwater Cutting Torch is an example of Air Reduction's contribution to the success of these ventures.

The torch is short—only 12 inches long—to reduce the "kick" when the cutting oxygen jet is released against surrounding water. It is furnished with either 75° or 90° head.

The metal shield which surrounds the tip performs a dual function: 1. It provides a pocket for an "artificial atmosphere" of compressed air which displaces any water around the cutting flames. (An extra hose connection is provided on the torch for the compressed air.) 2. The "feet" on the end of the shield hold the cutting flames at the correct distance from the metal surface.

This Airco torch, key to scores of "miracle" exploits of Navy and Seabee divers, is now available for underwater salvage and construction jobs you may encounter. And the knowledge and experience of Airco's Applied Engineering Division are at your call to insure the success of such jobs.

You will find much of interest and value to that success in Airco's new publication, "Underwater Cutting and Welding". It's free. Mail the coupon today for your copy.



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By-Laws of the American Welding Society

ARTICLE I

Membership

SECTION 1. *Classes of Members.*—The membership of the Society shall be divided into five classes:

(*a*) Honorary Members
(*b*) Sustaining Members
(*c*) Members
(*d*) Associate Members
(*e*) Student Members

who are defined and shall possess the qualifications presented in Section 2 hereof.

SECTION 2. *Qualifications and Privileges.*—(*a*) *Honorary Members.* An honorary member shall be a person of acknowledged eminence in the welding profession, or who may be accredited with exceptional accomplishments in the development of the welding art upon whom the AMERICAN WELDING SOCIETY may see fit to confer an honorary distinction. An Honorary Member shall have full rights of membership. There shall be at any one time not more than one Honorary Member for every five hundred members in the grades of Sustaining Member, Member and Associate Member. Not more than three (3) Honorary Members shall be elected in any one fiscal year.

(*b*) *Sustaining Members.* A Sustaining Member shall be an individual designated by a Corporation, Firm or Partnership interested in the science and art of welding, with full rights of membership.

(*c*) *Members.* A Member shall be an individual not less than 23 years of age, who shall have been for at least three years engaged in work having a direct bearing on the art or science of welding. Corporate Members of any major engineering society are also eligible for membership. Members shall have full rights of membership.

(*d*) *Associate Members.* An Associate Member shall be an individual interested in the art and practice of welding and allied processes. Associate Members shall have the right to vote but not to hold office except in Sections as may be provided for by the By-Laws of the Section.

(*e*) *Student Members.* A Student Member shall be an individual who is actually in attendance at a recognized College or University, taking a course leading to a degree. Student Members shall not have the right to vote or to hold office except in Student Chapters as may be provided for by the By-Laws of the Student Chapter. At the termination of the fiscal year of status as a student, affiliation as "Student Member" shall cease.

SECTION 3. *Corporate Members.*—Members in Classes (*a*), (*b*), (*c*) and (*d*) shall be considered the Corporate Members of the Society.

ARTICLE II

Election of Members

SECTION 1. *Honorary Members.*—Nominations for Honorary Membership may be submitted to the Board of Directors in writing, by any Corporate Member of the Society. Such nominations shall state the qualifications of the nominees for such membership. Honorary Members shall be elected by unanimous vote of the Board of Directors, except that no member of the Board of Directors shall vote upon his own admission.

SECTION 2. *Sustaining Members, Members and Associate Members.*—Applications for admission in the Sustaining Member, Member or Associate Member grades shall be in writing signed by the applicant, on forms prescribed for that purpose. Such applications shall be presented either to the Secretary of the Section with which the applicant desires to affiliate or to the Secretary of the Society. An applicant shall affiliate with the Section in which he resides, unless he desires to affiliate with another Section in which his business is located. Applicants residing in territory adjacent to a Section may join the Section. All applications shall be approved by the Board of Directors of the Section with which the applicant seeks affiliation. Applicants not residing within the territory of a Section and who do not plan to affiliate with an adjoining Section or with a Section due to business location mentioned above, are not subject to Section approval. All applications finally shall be approved by the Committee on Admissions.

SECTION 3. *Student Members.*—Applications for admission as a Student Member shall be in writing signed by the applicant, on forms prescribed for that purpose. If the applicant is in attendance at a college at which there is a Student Chapter such application shall be presented to, and approved by, the Faculty Adviser to the Student Chapter. Applicants in attendance at a

college where there is no Student Chapter, but who reside within the bounds of a Section, may choose to affiliate with such Section. In such case the application may be presented either to the Secretary of the Section or to the Secretary of the Society. All such applications shall be approved by the Board of Directors of the above-mentioned Section. Applicants who do not plan to affiliate with a Section, as permitted above, are not subject to Section approval. All applications finally shall be approved by the Committee on Admissions.

SECTION 4. *Change of Grade of Membership.*—Any member, other than Honorary Member, who desires to change his grade of membership, shall make application in writing therefor to the Secretary of the Society. Such application shall be passed upon by the Committee on Admissions.

SECTION 5. *Change of Section Affiliation.*—A Corporate Member, in good standing, who desires to transfer affiliation from one Section to another, as permitted in Article V, Section 5, shall make application therefor to the new Section. Such application shall be passed upon in like manner as an application for membership. A Corporate Member, in good standing, who changes his residence from the territory of one Section to that of another Section shall automatically be transferred to the Section to which he moves, unless the member makes application for membership in a different Section, as permitted in Article V, Section 5.

ARTICLE III

Resignation and Expulsion of Members

SECTION 1. *Resignation of Members.*—A member in good standing may tender his resignation from membership by filing with the Secretary written notice of his intention to resign. Such application shall be passed upon by the Committee on Admissions. If the application is granted, no dues paid by the applicant for less than one year in advance of the date of resignation shall be remitted to the applicant.

SECTION 2. *Expulsion of Members.*—Recommendation may be made to the Board of Directors for the expulsion of any member alleged to be guilty of conduct inimical to the welfare of the Society. Such recommendation shall be in writing and signed by ten or more corporate members in good standing, stating specific reasons therefor. If the Board decides that sufficient charges have been presented to warrant expulsion, they shall notify the accused of the charges presented against him, by mailing a communication to his latest address as it appears in the records of the Society. He shall then have the right to present a written defense, and to appear for trial, in person or by duly authorized representative, before a meeting of the Board of Directors, of which meeting he shall be notified at least thirty days in advance. Not less than two months nor more than four months after such meeting, the Board of Directors shall finally consider the case, and if in their opinion the charges have been sustained, the accused may be expelled or suspended for such period as the Board may determine, or he may be permitted to resign.

SECTION 3. *Nonpayment of Dues.*—Any member whose dues to the Society shall remain unpaid for a period of six months after the beginning of the fiscal year, shall be duly notified by the Secretary by letter directed to the latest post office address as it appears on the records of the Society, stating that if such dues are not paid within a period of one month, he shall automatically cease to be a member of the Society.

ARTICLE IV

Dues and Fees

SECTION 1. *Amount of Dues.*—The Annual Dues shall be as follows:

Honorary Members	None
Sustaining Members	$100.00
Members	15.00
Associate Members	10.00
Student Members	2.50

SECTION 2. *To Whom Payable.*—All dues shall be paid to the AMERICAN WELDING SOCIETY, at the headquarters office.

SECTION 3. *Date of Payment.*—The date for the payment of dues shall be September 1st. All dues shall be payable annually in advance except in the case of new members as provided in the following paragraph.

New members shall, at the time of election, pay an amount equal to full annual dues. At the beginning of the next fiscal year a pro rata allowance on a monthly basis shall be made for such advance payment.

SECTION 4. *Cancelled Dues.*—Any Member or Associate Member who shall have paid his dues for thirty-five (35) years, or who having paid his dues for thirty (30) years and having reached the age of sixty-five (65) years, shall thereafter be exempt from the payment of further dues, except that the number of years for which dues were paid as an Associate Member shall be reckoned as nine-tenths ($^9/_{10}$) of their number in the above provisions.

(Student Membership years not included.)

SECTION 5. *Remission of Dues.*—The Board of Directors may remit the dues of any member for any special reason.

SECTION 6. *Initiation Fees.*—There shall be no initiation fees.

SECTION 7. *Additional Funds.*—Funds in excess of those provided by the annual dues, which may be needed for research and other work, shall be secured by voluntary subscriptions to be solicited from the members, or from others specially interested. Such solicitation for additional funds shall be made only with the approval of the Board of Directors.

ARTICLE V

Section Organization

SECTION 1. *Formation of a Section and Name.*—The AMERICAN WELDING SOCIETY, in pursuance of the objects set forth in its Constitution, provides for the formation of Sections. The name of a Section shall be "The ——— Section of the AMERICAN WELDING SOCIETY."

SECTION 2. *Minimum Section Membership.*—Not fewer than twenty-five (25) members or eligible applicants for membership in the AMERICAN WELDING SOCIETY, in the Sustaining Member, Member and Associate Member grades may apply for authorization for the organization of a Section.

SECTION 3. *Section Organization Approval.*—The Board of Directors shall approve the formation of a Section.

SECTION 4. *Bounds of Section.*—The Board of Directors shall establish the bounds of each Section. The bounds of a Section shall be established on the basis of transportation facilities to the place of meeting. Seldom shall the bounds extend beyond one hundred (100) miles from the headquarters or place of meeting of the Section.

SECTION 5. *Membership.*—(*a*) All Corporate Members residing within the bounds of a Section, except those who have joined another Section due to business reasons, and all others who have joined the Section as permitted in Article II, Section 2, shall be members of the Section.

(*b*) Student Members residing within the bounds of a Section and attending a college where there is no Student Chapter may apply for membership in the Section. See Article II, Section 3.

(*c*) In general, the only Corporate Members who may join a Section are those residing within the bounds of the Section, or those residing in the territory adjacent to the Section, or those whose business is located within the territory of the Section. See Article II, Section 2.

(*d*) A Member may belong to one Section only.

SECTION 6. *Requirements of an Active Section.*—No Section shall be considered active unless it holds at least three meetings during a calendar year, and has a total paid membership of twenty-five (25) enrolled in the Sustaining Member, Member and Associate Member grades. When Sections fail to comply with the above requirements, the National Secretary shall report such facts to the National Board of Directors which shall act upon each case in accord with its merits.

SECTION 7. *Refund to a Section.*—Each active Section shall receive from the Society at the beginning of each fiscal year (October 1st) $100.00 and at the beginning of each quarter of the fiscal year 20% of the sum collected in dues during the preceding quarter from those of its members who are in the grades of Sustaining Member, Member and Associate Member, provided that each newly organized Section shall receive $100.00 on date of acceptance of organization and provided further that on the following October 1st each such newly organized Section shall receive $100.00 less over-payment prorated on a monthly basis for the first fiscal year. At the time of organization of a new Section, returns shall be made on the annual dues of members newly enrolled in the Society during the six prior months to the date of organization of the Section, unless refund has been paid to another Section for such members. Refunds shall be paid to the Section with which each member is affiliated at the time when refund payments are due.

SECTION 8. *Solicitation of Contributions.*—Sections may solicit contributions from members or others only within limits approved by the National Board of Directors.

SECTION 9. *Reports to the Society.*—(*a*) The Section Secretary, or such other person as he shall designate, shall submit a report in writing of each meeting of the Section to the Secretary of the Society with copy to the District Vice-President, which shall show the attendance of members and guests, business transacted at the meeting, including papers and discussions presented thereat, and any other matters which the Section shall deem of interest to the Society. The Section Secretary shall also make an annual report to the Secretary of the Society, with copy to the District Vice-President.

(*b*) The Section Treasurer shall make an annual report to the Secretary of the Society with copy to the District Vice-President. Such report shall give a complete record of the finances of the Section, showing the amounts received and expended and the sources and purposes thereof in detail. The Section Treasurer shall also file such other reports of the financial condition of the Section at such other times as may be requested by the Board of Directors.

SECTION 10. *Section Affiliates.*—Sections may take into their membership "Affiliates of Sections," who are not members of the Society. The annual dues for an "Affiliate" shall be established by the Section, but shall not exceed $5.00. Affiliates shall have no rights or privileges of membership in the Society, except to attend and participate in Section meetings according to the By-Laws of the Section.

SECTION 11. *Publication of Section Papers.*—Any address or paper presented before a Section may be offered for publication in THE WELDING JOURNAL under the general provisions established for this procedure.

SECTION 12. *Section By-Laws.* The By-Laws of a Section shall not conflict with any provisions of the Constitution or By-Laws of the AMERICAN WELDING SOCIETY. (Outline of recommended By-Laws for a Section may be procured from the Secretary of the Society).

SECTION 13. *Disbanded Sections.*—When a Section ceases to function the Section Treasurer shall return to the Society all remaining funds.

ARTICLE VI

District Organization

SECTION 1. GEOGRAPHICAL DISTRICTS.—There shall be seven Districts known as No. 1—The New York and New England, No. 2—The Mid-Eastern, No. 3—The Southern, No. 4—The Central, No. 5—The Mid-Western, No. 6—The Mid-Southern, and No. 7—The Western, Districts, the boundaries of which shall be determined by the Board of Directors.

SECTION 2. *Minimum Number of Sections.*—No District shall be considered as "operative" unless it contains at least three active Sections.

SECTION 3. *District Affiliation.*—Should the territory of any Section lie in more than one District as defined above, then the entire territory of said Section shall be considered as belonging to the District in which the headquarters of the Section is located.

SECTION 4. *District Executive Committee.*—To facilitate cooperation between the Sections, there shall be an Executive Committee in each District which shall consist of the District Vice-President as Chairman and each Section Chairman within that District.

SECTION 5. *District Conventions.*—District conventions may be held subject to the approval of the National Board of Directors in each instance. They shall be held under the supervision of the District Executive Committee. The District Vice-President with the approval of the District Executive Committee shall appoint a local Convention Committee, which shall have, subject to the approval of the District Vice-President, full authority and responsibility for organizing and conducting the Convention in all its details including the selection of papers, the arrangement of sessions and the entertainment features. The Secretary of the Society shall furnish for the guidance of the local Convention Committee an Outline of Procedure.

All technical papers included in the program shall be submitted for consideration for publication in THE WELDING JOURNAL of the AMERICAN WELDING SOCIETY. The Local Convention Committee shall furnish a copy of the proposed program to the Society's Convention Committee and also a budget and a statement of plans for raising funds for the consideration of the Society's Finance Committee. Upon request of the Local Convention Committee, the Society's Program, Publicity, Manufacturers, and Convention Committees shall cooperate fully in arranging for the District Meeting.

SECTION 6. *District Nominations.*—Before March 1st of the years when a District Vice-President is due for election, the District Vice-President, with the approval of the District Executive Committee, shall appoint a Nominating Committee consisting of a member from

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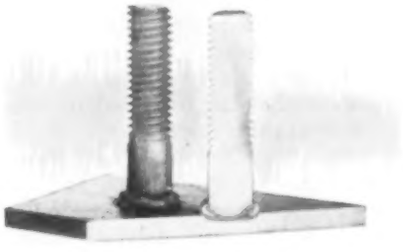

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each Section in the District. The Nominating Committee shall report to the National Secretary not later than the 10th day of May of that year, the name of the nominee they have selected for Vice-President, together with the written acceptance of the nominee included in the report.

Independent nominations may be made by petition of twenty-five (25) or more qualified voters, sent to the National Secretary not later than July 1st; such petitions for the nomination of District Vice-Presidents shall be signed only by qualified voters within the District concerned. (See Article IX, Section 1.)

Each year the National Ballot for Nomination of Officers shall include the names of the District Vice-Presidents nominated by the District Nominating Committees and names of nominees nominated by petition in accordance with provision above.

Only District members, qualified to vote, shall be eligible to vote for District Vice-Presidents.

SECTION 7. *Vacancies.*—The Executive Committee of each District shall have the power to fill a vacancy in the office of Vice-President of that District for an unexpired term whenever such vacancy occurs.

ARTICLE VII

Student Chapters

SECTION 1. *Formation of a Student Chapter and Name.*—A Student Chapter in affiliation with the AMERICAN WELDING SOCIETY, composed of students of schools of engineering of recognized reputation, may be organized upon favorable vote by the Board of Directors. Authority for the organization of a Student Chapter at any institution shall automatically lapse if not used within one year from the date granted. The name of such an affiliated society shall be "The ——— Student Chapter of the AMERICAN WELDING SOCIETY."

SECTION 2. *Application to Organize a Student Chapter.*—Applications for the establishment of Student Chapters in the AMERICAN WELDING SOCIETY shall be made to the Board of Directors.

SECTION 3. *Qualifications.*—The qualifications required of a proposed Student Chapter shall include:

(*a*) An organization of students in an engineering school of approved standing.

(*b*) The endorsement of the application by the head of one of the Engineering Departments of the school.

(*c*) A minimum membership of 15 student members or eligible applicants for student membership in the AMERICAN WELDING SOCIETY.

(*d*) A Faculty Adviser to the Student Chapter whose duties shall be to consult with and advise the Student Chapter on matters relating to the general conduct of the Chapter. The Faculty Adviser shall be a Corporate Member of the Society and shall be a member of the faculty of the engineering school at which the Student Chapter is organized.

SECTION 4.—*Membership.*—All Student Members attending a school at which there is a Student Chapter shall be members of the Student Chapter.

SECTION 5. *Refund to a Student Chapter.*—Each active Student Chapter shall receive from the Society at the beginning of each academic year $25.00 to be used for expenses in promoting the activities of the Chapter.

SECTION 6. *Reports to the Society.*—Each Student Chapter shall submit to the Board of Directors an annual report not later than the end of each academic year, which shall include:

(*a*) A summary statement of the meetings held during the academic year; giving date of each, the attendance, the principal speaker and his subject and other pertinent information.

(*b*) Names of the officers and the members by classes, at the date of the report.

SECTION 7. *Publication of Papers.*—Any address or paper presented before a Student Chapter may be offered for publication in THE WELDING JOURNAL under the general provisions established for this procedure.

SECTION 8. *Student Chapter By-Laws.*—The By-Laws of a Student Chapter shall not conflict with any provisions of the Constitution or By-Laws of the AMERICAN WELDING SOCIETY. (Outline of recommended By-Laws for a Student Chapter may be procured from the Secretary of the Society.)

SECTION 9. *Disbanded Student Chapters.*—A Student Chapter may be disbanded upon the approval of the Board of Directors, if it becomes inactive or if its continuance is considered not for the best interest of the Society. No Student Chapter shall be considered active unless it holds at least three meetings during the academic year. When a Student Chapter ceases to function the Chapter Treasurer shall return all remaining funds to the Society.

ARTICLE VIII

Officers and Terms of Office

SECTION 1. *List of Officers.*—The Officers of the Society shall be a President, a First Vice-President, a Second Vice-President, seven District Vice-Presidents, a Secretary, a Treasurer, three latest Past-Presidents, if living and continuing to be members, twelve Directors-at-Large and Honorary Directors.

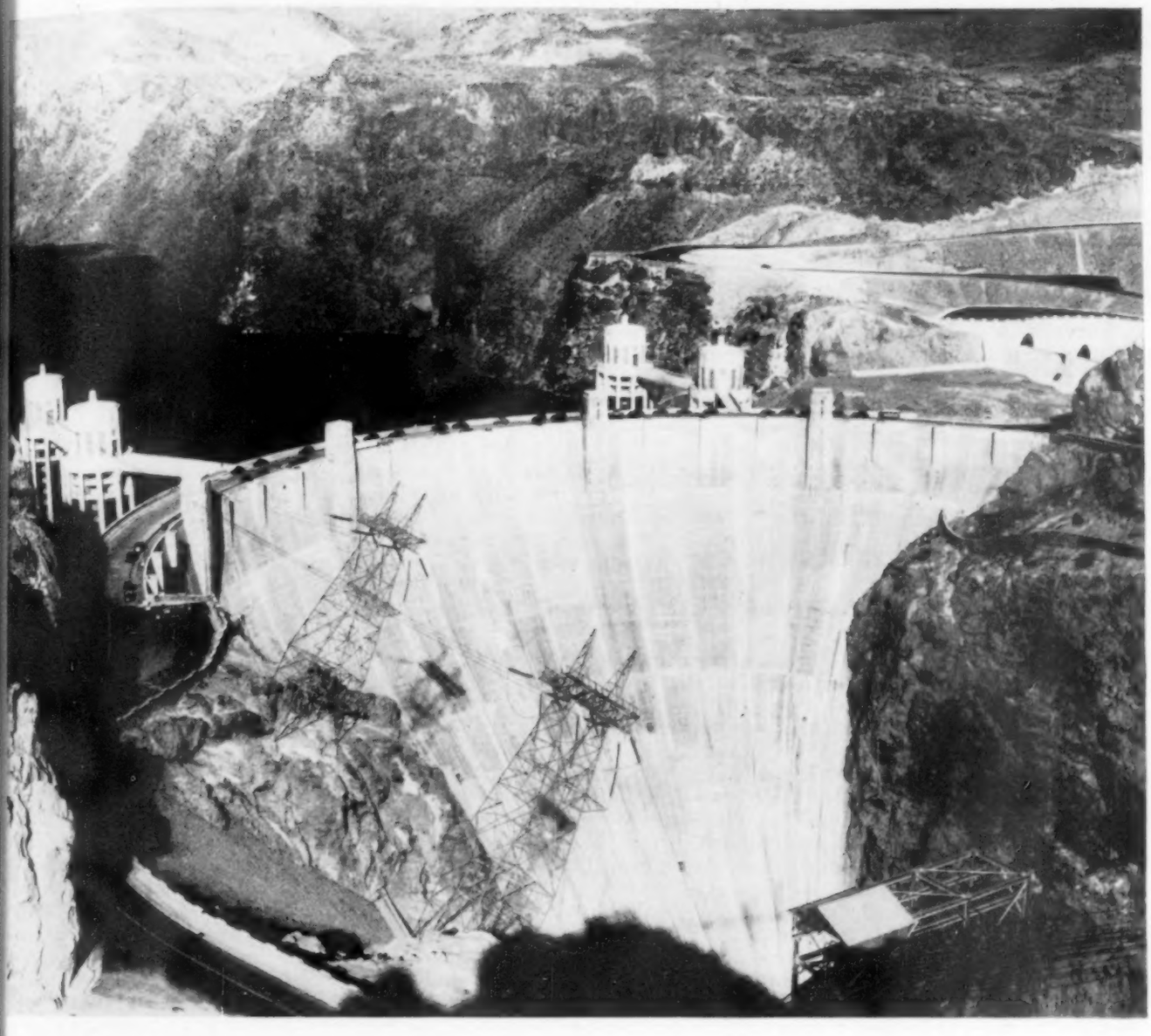
SECTION 2. *President.*—The President shall be elected by the Society for a term of one year and may be re-elected, at any time, for a second term of one year, but in no case shall he serve in this capacity for more than two terms.

SECTION 3. *Vice-Presidents.*—A First Vice-President and a Second Vice-President shall be elected by the Society for a term of one year and each may be re-elected, at any time, for a second term of one year, but in no case shall either serve in the same capacity for more than two terms.

SECTION 4. *District Vice-Presidents.*—The District Vice-Presidents shall be elected by their Districts for a period of two years and each may be re-elected, at any time, for a second term of two years, but in no case shall he serve in this capacity for more than two terms. The odd-numbered Districts, viz., (1) New York and New England, (3) Southern, (5) Mid-Western and (7) Western, shall elect their Vice-Presidents during odd-numbered calendar years. The even-numbered Districts, viz., (2) Mid-Eastern, (4) Central and (6) Mid-Southern, shall elect their Vice-Presidents during even-numbered calendar years. (In order to make this plan operative, in the year 1945 the Mid-Eastern, Central and Mid-Southern Districts shall elect their Vice-President for a term of one year, and the other Districts for a term of two years.)

SECTION 5. *Treasurer.*—A Treasurer shall be elected by the Society for a term of three years and is eligible for re-election.

SECTION 6. *Directors-at-Large.*—The Directors-at-Large shall be selected by the Nominating Committee with due consideration to geographical distribution. Each year, four Directors-at-Large shall be elected to serve for a period of three years. Directors shall not be eligible for re-election to the same office until at least



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one full term of three years shall have elapsed after the end of their respective terms.

SECTION 7. *Honorary Directors.*—Honorary Directors shall be persons of acknowledged eminence in the welding profession, or who may be accredited with exceptional accomplishments in the development of the welding art who have rendered exceptional service to the AMERICAN WELDING SOCIETY, upon whom the Society may see fit to confer an honorary distinction. An Honorary Director shall have the same rights and privileges as other members of the Board of Directors. The total number of Honorary Directors shall not exceed three (3) at any one time, and not more than one Honorary Director shall be elected in any one fiscal year.

SECTION 8. *Secretary.*—A Secretary shall be appointed by the Board of Directors for a term of one year.

SECTION 9. *Assistant Secretary.*—The Board of Directors may appoint an Assistant Secretary for a term of one year.

SECTION 10. *Assistant Treasurer.*—The Board of Directors may appoint an Assistant Treasurer for a term of one year.

ARTICLE IX

Nomination and Election of Officers

SECTION 1. *Nominations.*—Nominations for officers except Honorary Directors and Secretary, shall proceed as follows:

(*a*) Nominations for District Vice-Presidents shall be made by the District Nominating Committees. See Article VI, Section 6. The National Nominating Committee shall select nominees for the other offices falling vacant. See Article XII, Section 7. The names of the nominees for each office shall be published in the June issue of THE WELDING JOURNAL of the AMERICAN WELDING SOCIETY.

(*b*) The Secretary shall mail, on or before the first day of June of each year, to each member entitled to vote, a notice that nominations for officers must reach the Secretary not later than the first day of July. This notice shall outline the vacancies of elective offices that shall be filled at the next regular election and request nominations for such offices. This notice shall contain a copy of this Section and the list of nominees recommended by the National and District Nominating Committees and information that no name shall appear on the final voting ballot unless proposed by at least twenty-five (25) qualified Corporate Members. This notice shall also contain the names of the members of the National Nominating Committee.

(*c*) The nomination ballots must be placed in a plain envelope and sealed; then inserted in a second envelope and sealed. The voter shall then sign his name thereon in ink and mail it to the Secretary. The Secretary shall certify to the competence and signature of all voters returning endorsed nomination ballots and shall then deliver them unopened to the National Nominating Committee.

A nomination ballot without autographic endorsement of the voter written on the outside envelope shall be considered defective and shall not be canvassed by the Nominating Committee. The Nominating Committee shall first open and destroy the outer envelopes of all properly endorsed ballots, and shall then open the inner envelopes, canvass the ballots and certify the results to the Secretary. If no nominations, other than those proposed by the Nominating Committees, are made by twenty-five (25) qualified members, then the Secretary shall treat the nomination ballots as Election Ballots and shall cast the ballot for the election of the candidates so nominated.

SECTION 2. *Election.*—(*a*) If a member, not proposed by the Nominating Committees, is duly nominated as provided for in Section 1 of this Article, then the Secretary shall mail, on or before the 15th day of July of that year, to each member entitled to vote, a ballot stating the names of the candidates for the several offices falling vacant and the time for the closure of the voting.

The ballot sheet shall list the names of the candidates proposed by the Nominating Committees and the respective offices for which they are candidates and the names of candidates nominated by letter ballot as provided in Section 1 Paragraphs (*b*) and (*c*) of this Article. Candidates selected by the Nominating Committees shall be identified by an asterisk.

(*b*) The voter shall prepare his ballot by means of a cross placed opposite the name of each candidate for whom he wishes to vote. The voter shall enclose said ballot in a plain envelope and seal same. He shall then enclose the sealed envelope in a second envelope marked "Ballot for Officers," seal same and sign his name thereon in ink, for identification and mail it to the Secretary. The Secretary shall certify to the competence and signature of all voters and shall then deliver them unopened to the Tellers of Election.

A ballot without the autographic endorsement of the voter written on the outside envelope shall be considered defective and shall be rejected by the Tellers of Election. A ballot which has choice indicated for more names than there are offices to be filled shall be considered defective and shall be rejected by the Tellers.

SECTION 3. *Closing Date for Election.*—The voting for the election of officers shall close at 1 o'clock in the afternoon on the last Thursday in August of each year. The Tellers shall not receive any ballots after the stated time for the closure of the voting.

The Tellers of Election shall first open and destroy the outer envelopes and shall then open the inner envelopes, canvass the ballots and certify the results to the Secretary. The candidates having the greatest number of votes for their respective offices, shall be considered elected for the ensuing year.

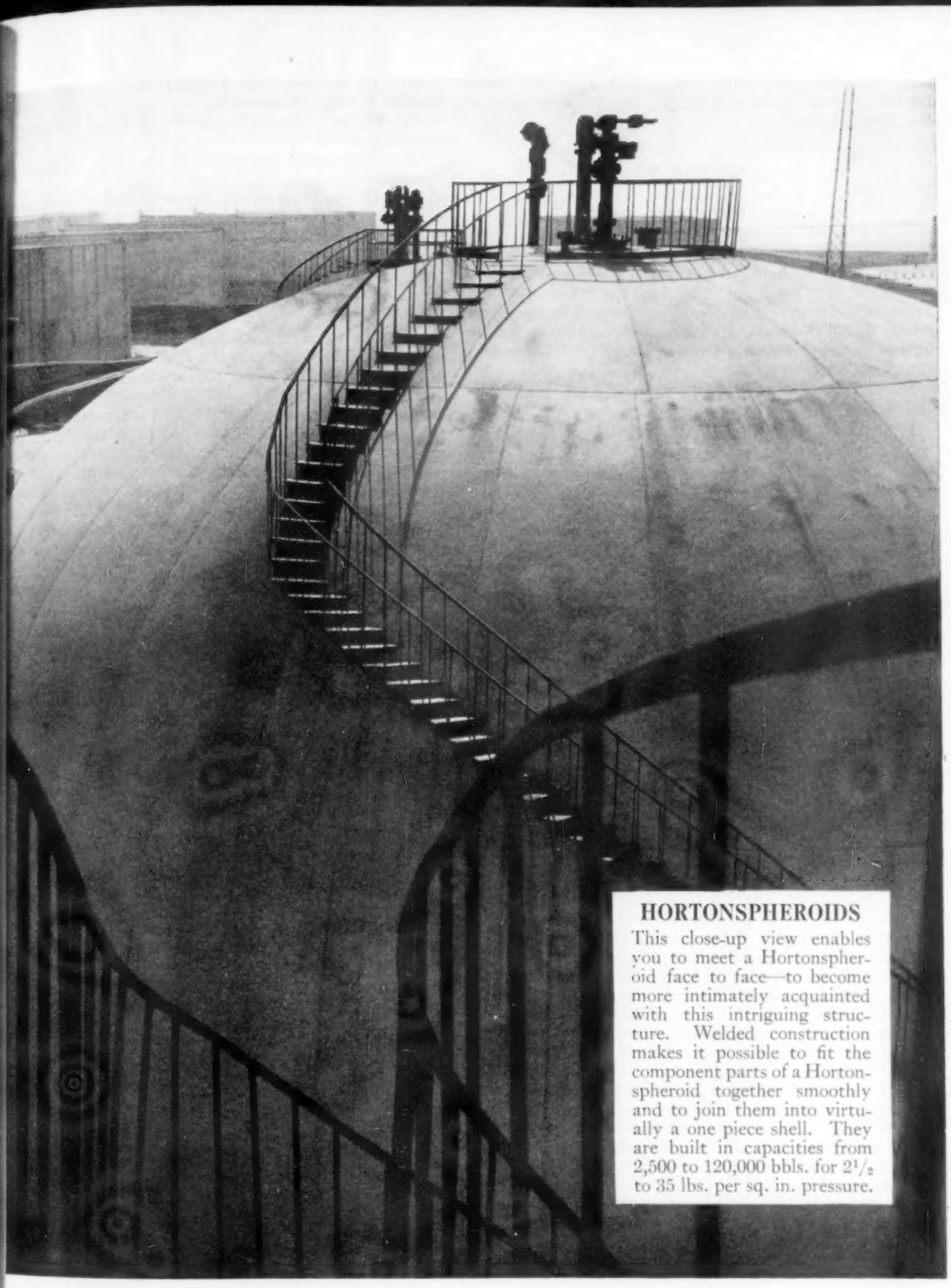
SECTION 4. *Tie Votes.*—In case of a tie in the vote for any office, the President shall cast the deciding vote.

SECTION 5. *Announcement of Election.*—The names of the Elected Officers shall be announced by the Presiding Officer at the Annual Meeting of the Society, if such is held, and shall be published in the October issue of THE WELDING JOURNAL.

SECTION 6. *Date to Assume Office.*—The term of all Elected Officers shall begin on the adjournment of the Annual Meeting of the Society. If no Annual Meeting is held, the new officers shall take office on October 1st. Officers shall continue in their respective offices until their successors have been elected and qualified.

SECTION 7. *Tellers of Election*—When more than one candidate is nominated for any office, thus requiring an election, the President shall, on or before the last Thursday in August appoint three (3) Tellers of Election whose duty shall be to canvass the votes cast and certify the same to the Secretary and to the President or the Presiding Officer, at the Annual Meeting. Their term of office shall expire when their report of the canvass has been presented and accepted.

SECTION 8. *Honorary Directors.*—Nominations for Honorary Directorship may be submitted to the Board of Directors in writing, by any Corporate Member of the Society. Such nominations shall state the qualifications of the nominee for this office. Honorary Directors shall be elected by unanimous vote of the Board of Directors, except that no member of the Board of Directors shall



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vote upon his own admission. They shall hold office for life or until removed from office by majority vote of the Board of Directors.

ARTICLE X

Management

SECTION 1. *Board of Directors.*—The affairs of the Society shall be managed by a Board of Directors consisting of the President, the First and Second Vice-Presidents, the seven District Vice-Presidents, the three latest Past-Presidents, if living and continuing to be members, the Treasurer, twelve Directors-at-Large and Honorary Directors.

SECTION 2. *Duties of Board of Directors.*—The Board of Directors shall have the power:

(*a*) To manage the affairs of the Society, except as otherwise provided by law, or by these By-Laws.

(*b*) To purchase or otherwise acquire for the Society any property rights and privileges which the Society is authorized to acquire, or to dispose of such, at such prices and on such terms and conditions and for such considerations as they think fit.

(*c*) To appoint Executive Officers and fix their salaries.

(*d*) To determine who shall be authorized to sign, on behalf of the Society, notes, receipts, acceptances, endorsements, checks, releases, any and all contracts and other documents, and shall make such authorization.

(*e*) To perform such other acts as may be necessary to carry out the purpose of the Society.

SECTION 3. *Vacancies in Board of Directors.*—In each case of vacancy occurring in the Board of Directors through death, resignation, disqualification or other cause, the remaining Directors, by letter ballot, may elect, or appoint a successor to hold office for the unexpired portion of the term of the retiring Director; and in the event that a quorum of the Board of Directors does not exist, the affirmative vote of a majority of the remaining Directors shall become effective. However, if the retiring Director is a District Vice-President then the vacancy shall be filled as provided in Article VI Section 7.

SECTION 4. *Duties of President.*—The President shall have general supervision of the affairs of the Society, under the direction of the Board of Directors. He shall preside at the meetings of the Society, of the Executive Committee and of the Board of Directors, at which he may be present, and shall be ex-officio a member of all committees. He shall submit a report of the operations of the Society for the fiscal year to the Board of Directors at their last regular meeting preceding the Annual Meeting and to the members at the Annual Meeting.

SECTION 5. *Duties of First and Second Vice-Presidents.*—The First and Second Vice-Presidents, in order of seniority, in the absence or disability of the President, shall preside at meetings of the Society, of the Executive Committee and of the Board of Directors, and discharge his duties.

SECTION 6. *Duties of District Vice-Presidents.*—The District Vice-President shall be the official representative of the Society in his District. He shall have the following duties:

(*a*) To supervise and promote the affairs of the Society in his District under the direction of the National President and the National Board of Directors.

(*b*) To visit the Sections in his District at least once each year, if at all possible.

(*c*) To assist in the organization of new sections in his District.

(*d*) To represent his District as a member of the Section Advisory Committee.

(*e*) To serve as Chairman of the District Executive Committee.

(*f*) To serve as a member of the National Board of Directors.

(*g*) To render an annual report to the National Board of Directors covering the condition of each Section within his District.

SECTION 7. *Duties of Secretary.*—(*a*) The Secretary shall be, under the direction of the President and the Board of Directors, the Chief Executive Officer of the Society.

(*b*) The Secretary shall be expected to attend all meetings of the Society, of the Executive Committee and of the Board of Directors; prepare the business thereof and duly record the proceedings thereof.

(*c*) The Secretary shall see that all moneys due the Society are carefully collected, and without loss transferred to the custody of the Treasurer.

(*d*) The Secretary shall carefully scrutinize all expenditures and exert every effort to secure economy in the administration of the Society and shall personally certify the accuracy of all bills or vouchers on which money is to be paid.

(*e*) The Secretary shall have charge of the books of account of the Society and shall furnish monthly to the Treasurer a statement of receipts and expenditures under their several headings, and also a statement of monthly balances, and shall furnish from time to time such other statements as may be required.

(*f*) The Secretary shall conduct the official correspondence of the Society and keep full records thereof.

(*g*) The Secretary shall have charge of the Society's rooms and all property of the Society.

(*h*) The Secretary shall engage such employees as may be authorized and shall be responsible for the work of all employees of the Society.

(*i*) The Secretary shall perform all other duties which may, from time to time, be assigned by the Board of Directors.

(*j*) The Secretary shall devote the entire time of employment to the affairs of the Society unless otherwise authorized by the Board of Directors.

(*k*) The Secretary shall give the Society a bond in a sum, and with one or more securities as required by, and satisfactory to, the Board of Directors for the faithful performance of the duties of this office, and the restoration to the Society in the case of death, resignation or removal from office of the Secretary, of all books, papers, vouchers, money or other property of whatever kind in the possession of the Secretary, belonging to the Society. The cost of the bond shall be borne by the Society.

SECTION 8. *Duties of Treasurer.*—(*a*) The Treasurer shall receive all moneys and deposit the same, to the credit of the Society, in such depositories as may be designated by the Board of Directors.

(*b*) The Treasurer shall disburse the funds of the Society as may be ordered by the Board of Directors, taking the proper vouchers to such disbursements.

(*c*) The Treasurer shall furnish, at regular intervals, to the Board of Directors a statement of receipts and expenditures under their several headings and also a statement of monthly balances. He shall make an annual report and such other reports as may be prescribed by the Board of Directors. The annual report shall be certified by a competent public accountant selected by the Board of Directors.

(*d*) The Treasurer shall give the Society a bond in a sum and with one or more securities as required by, and satisfactory to, the Board of Directors for the faithful performance of the duties of his office and the restora-

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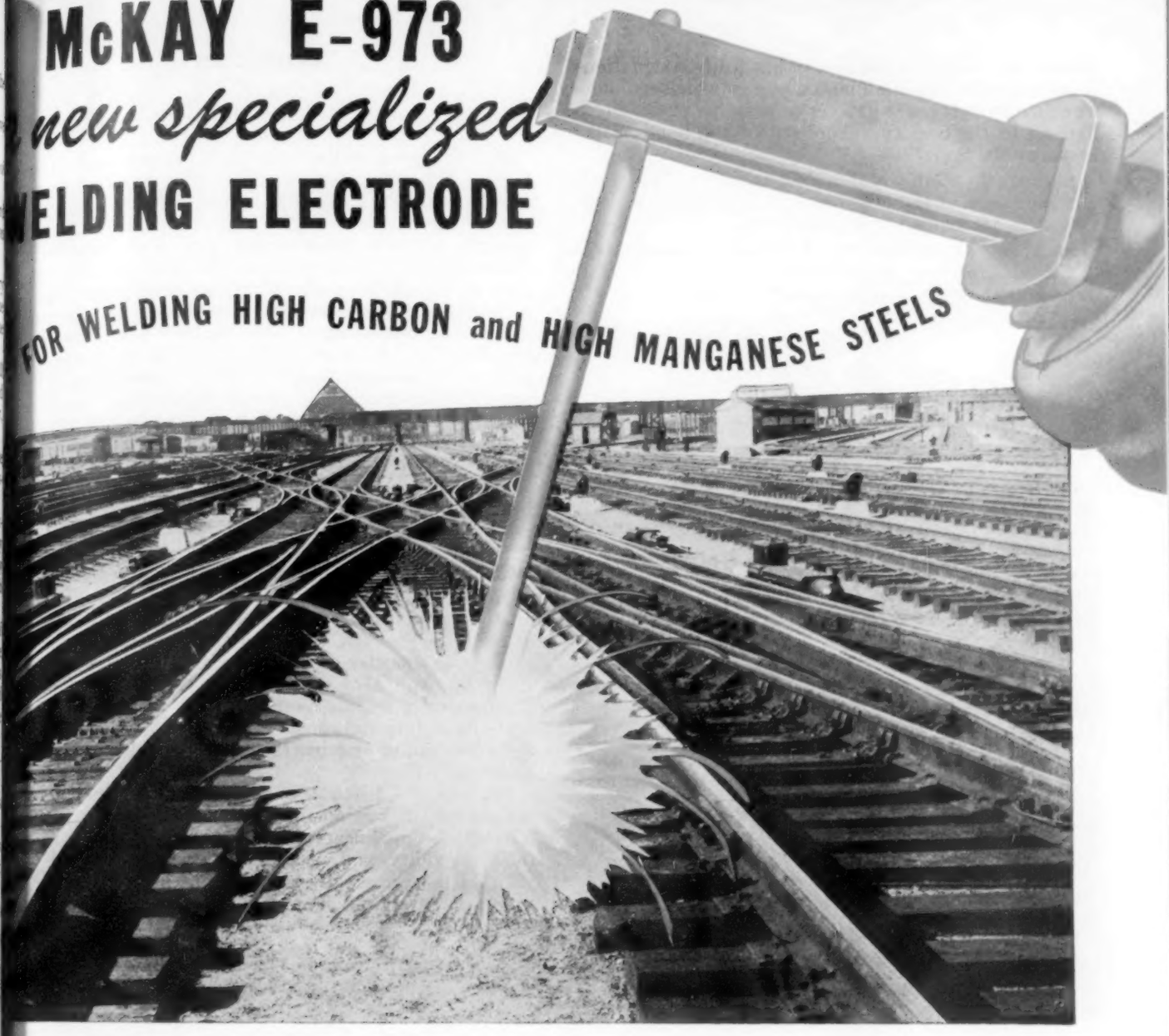
new specialized
WELDING ELECTRODE

FOR WELDING HIGH CARBON and HIGH MANGANESE STEELS



you can have a *better* welding electrode . . . one *lasts longer* and is *easier to apply* . . . for building or otherwise welding high carbon and/or high manganese steels!

McKAY E-973 is specially made for the job. The metal will not cross check or crack under the arc. Although soft in the "as welded" state, it work hardens rapidly . . . permitting heavy pads to be built up without danger of mushing down, cracking or spalling or flaking when subjected to constant wear and service. Exceptionally smooth flowing properties make it unusually easy to apply. It does not require pre-heating or frequent delay for peening.

McKAY E-973 is the result of intensive research and service testing. It was specially developed for railway use but has wide application in other industries where welding of comparable steel is involved . . . effective demonstration of the McKAY policy of manufacturing electrodes to meet *specific needs.*

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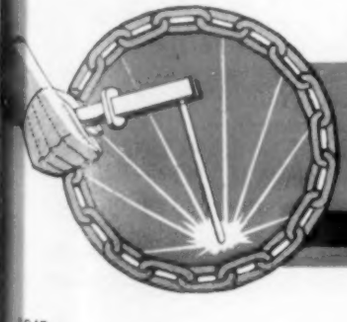
General Sales Office: York, Pa.



THE McKAY COMPANY
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WELDING ELECTRODES . . . COMMERCIAL CHAINS . . . TIRE CHAINS

tion to the Society in the case of his death, resignation or removal from office of all books, papers, vouchers, money or other property of whatever kind in his possession belonging to the Society. The cost of the bond shall be borne by the Society.

SECTION 9. *Duties of Assistant Secretary.*—The Assistant Secretary in the absence or disability of the Secretary shall act instead of the Secretary.

SECTION 10.—*Duties of Assistant Treasurer.*—The Assistant Treasurer in the absence or disability of the Treasurer shall act instead of the Treasurer.

ARTICLE XI

Meetings, Quorums, Exhibits and Notices

SECTION 1. *Annual Meeting.*—The Society shall hold an Annual Meeting each year, (unless prevented by governmental restrictions), at such time between September 1st and October 31st, and at such place as the Board of Directors may designate.

SECTION 2. *Special Meetings.*—Special meetings of the Society may be called at any time by the Board of Directors.

SECTION 3. *Board of Directors.*—Meetings of the Board of Directors shall be held at the call of the President.

SECTION 4. *Notice of Meetings.*—Notices of all meetings of the Society shall be mailed to the members at least 30 days prior to the date of such meeting, and to the Board of Directors at least two weeks prior to the date of their meeting, and shall designate the time and place of the meeting and the principal business to come before it.

SECTION 5. *Quorum at Meetings.*—Twenty (20) members, entitled to vote, shall constitute a quorum at meetings of the Society and ten (10) Directors shall constitute a quorum at meetings of the Board of Directors.

SECTION 6. *Organization of Annual Meeting.*—The Society's Convention Committee shall plan and make arrangements and correlate activities, in connection with Annual Meetings in cooperation with the Program, Publicity and Manufacturers Committees. The Chairman of the Section where the meeting is to be held, or someone else designated by that Section, shall be appointed Vice-Chairman of the Society's Convention Committee. In making local arrangements for the Annual Meeting, the local convention committee shall be guided by an Outline of Procedure, furnished by the Society's Secretary. The Society's Secretary, in consultation with the Treasurer, and the Chairmen of the Convention, Program, Publicity, and Manufacturers Committee, shall prepare a budget and submit it to the Finance and Executive Committees for approval. A copy of this budget shall be submitted to each member of the Society's Convention Committee for guidance.

SECTION 7. *Exhibits.*—The Society may also, in connection with the Annual Meeting or otherwise, hold an exhibit if the Board of Directors shall so determine. After approval of the Board of Directors, the Chairman of the Society's Manufacturers Committee shall carry on negotiations with the Exhibition Sponsor, wherever practicable. If conditions make it advisable for the District or the Local Section to conduct the preliminary negotiations for an exhibit, approval of the Society's Manufacturers Committee and Board of Directors must first be secured to all proposed agreements before committing the Society to participation.

ARTICLE XII

Committees

The following committees shall be appointed, or approved, if appointment is provided for otherwise herein, each year by the President, by and with the approval of the Board of Directors, as soon as possible after the Annual Meeting (or October 1st), and vacancies in committees shall be filled in the same manner. The President shall be ex-officio member of all committees.

SECTION 1. *Executive Committee.*—An Executive Committee consisting of not less than five members of the Board of Directors shall exercise, at times when the Board of Directors is not in session, such part of the authority of the Board in the administration of the affairs of the Society, as may from time to time be delegated to it. The Chairman and Executive Secretary of the Welding Research Council and the Chairman and Secretary of the Technical Activities Committee shall be ex-officio members of this Committee without the power to vote.

SECTION 2. *Finance Committee.*—A Finance Committee, selected from members of the Board of Directors, which shall pass upon all expenditures, prepare the annual budget and have general charge of the finances of the Society. The Treasurer shall be Chairman of the Finance Committee

SECTION 3. *Membership Committee.*—A Membership Committee of five or more members whose duties shall be to formulate and execute plans and prepare literature for maintaining and increasing the membership of the Society.

SECTION 4. *Admissions Committee.*—A Committee on Admissions of five members whose duty it shall be to pass on the qualifications of all members to determine their eligibility and classification as members of the Society, to approve transfers in Section affiliation and to approve resignations from membership.

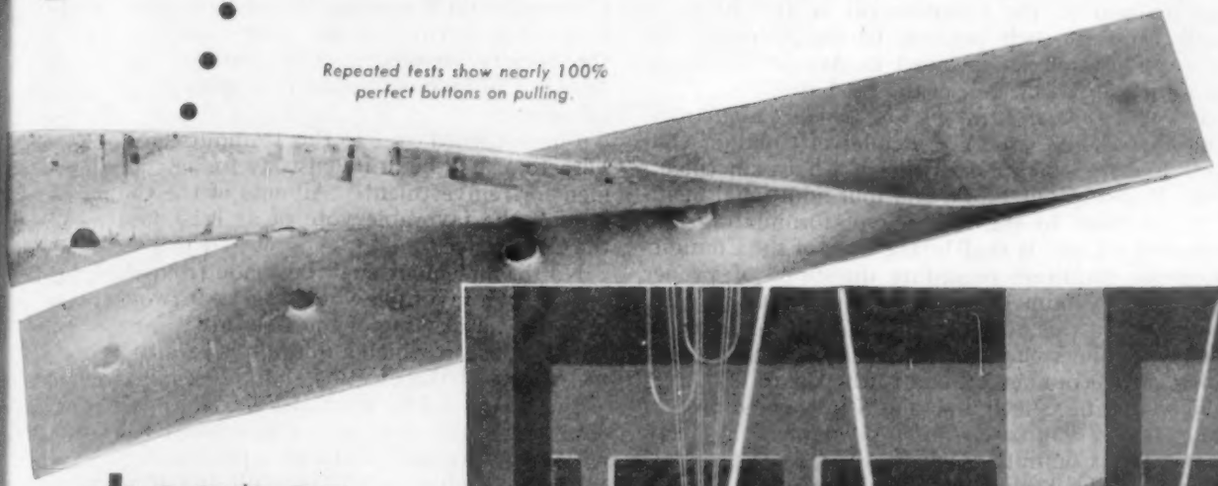
SECTION 5. *Program Committee.*—A Program Committee shall plan and make arrangements for technical programs for all meetings of the Society; it shall solicit and pass upon all papers offered for presentation before national meetings; it shall cooperate, when called upon, with local groups in arrangements for Section and District Meetings.

SECTION 6. *Publication Committee.*—The Publication Committee shall solicit papers for publication and shall pass upon all papers offered to the Society for publication in its Journal; it shall have the power to edit papers, in accordance with established rules governing the publication of the Society's WELDING JOURNAL, as approved by the Board of Directors.

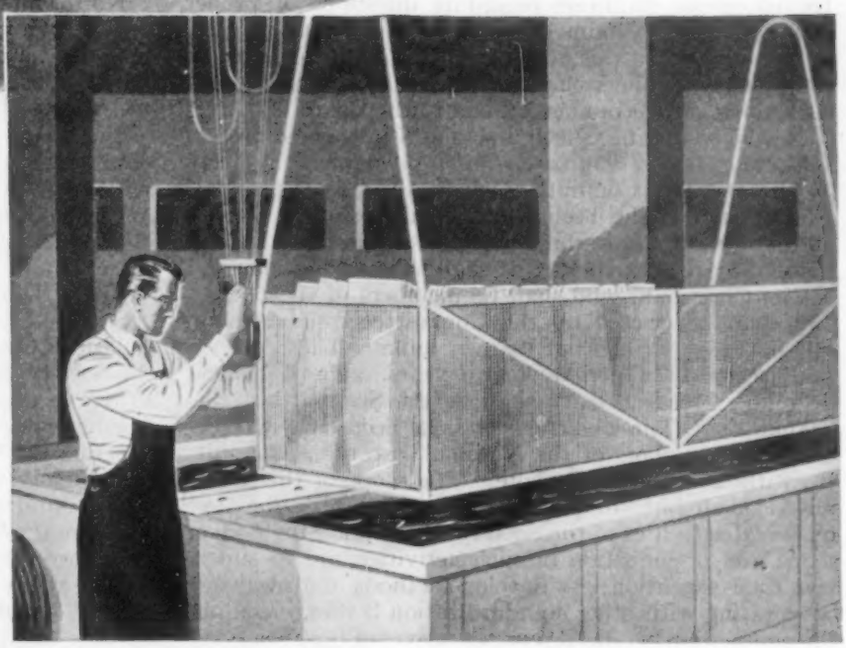
SECTION 7. *Nominating Committee.*—A Nominating Committee of seven members. The Committee shall consist of a Chairman who shall be a Past-President of the Society and six members (not members of the Board of Directors), one of whom shall be a Past-President of the Society. Announcement of the appointment and personnel of the Committee shall be made by the President through publication in THE WELDING JOURNAL on or before March 1st. The Committee shall deliver to the Secretary in writing on or before the 10th day of May of that year, the names of its nominees for the various elective offices next falling vacant with the written acceptance of each nominee. (District Vice-Presidents shall be nominated by each District Nominating Committee. See Article VI, Section 6). This Committee shall also canvass the nomination ballots and certify the result to the Secretary.

SECTION 8. *Constitution and By-Laws Committee.*—A Constitution and By-Laws Committee comprising a

How to spot weld aluminum



Repeated tests show nearly 100% perfect buttons on pulling.



. cheaper.. . better... . FASTER!

New DIVERSEY PROCESS to prepare aluminum for welding, skyrockets production...cuts rejects!

Here's a typical case record from DIVERSEY files. Spot weld production in one war plant jumped from 3,500,000 to 7,000,000 welds a month . . . after adoption of the DIVERSEY PROCESS for treating aluminum before welding.

In addition, uniformly high quality spot welds consistently exceed government specifications . . . operators average between 400 and 600 welds between tip cleaning . . . and the DIVERSEY PROCESS with 3 men now does the work formerly done by 50 people removing oxide film by wire brushing.

These remarkable results are due to the chemically clean welding surfaces produced by this new method. The DIVERSEY PROCESS *completely* cleans and removes oxide film . . . known to set up high electrical resistance that seriously affects the uniformity and quality of welds.

The DIVERSEY PROCESS is safe, gentle to aluminum surfaces, and NON-CRITICAL. It requires no specialized personnel. By minimizing rejects, raw material spoilage and labor charges while stepping up production of acceptable welds, this process assures cheaper, better, faster aluminum spot welding operations. For further details, send for free technical bulletin No. 501. Write to: Metal Industries Dept.

EXPERT HELP ON METAL CLEANING

If you need help on any metal cleaning . . . or working . . . problem, just call for the DIVERSEY D-Man. Backed by a Research Laboratory that has spent 18 years developing special purpose products, he is always on deck to lend a helping hand . . . often finds ways to step up production with less manpower.

DIVERSEY D-MAN

DIVERSEY PROCESS
for Surface Treating Aluminum

1. Use DIVERSEY D-C No. 36 in still tank solution to remove all oil, grease, foreign matter from welding surfaces. Powerful cleaning action inhibited to prevent pitting or staining.

2. Use DIVERSEY D-C No. 1 to remove oxide film by treating aluminum in still tank solution. D-C No. 1 is a non-toxic, non-fuming powder developed to replace harsh, corrosive, dangerous acids.

THE DIVERSEY CORPORATION
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Chairman and two other members. This Committee shall receive suggestions for revisions to the Constitution or By-Laws and be responsible for the preliminary wording of such revisions. It shall see that the By-Laws of Sections and Student Chapters of the Society shall not conflict with any provision of the Constitution and By-Laws of the AMERICAN WELDING SOCIETY. This Committee shall consider and report upon any petition for revision to the Constitution or the By-Laws and shall transmit such petition to the Secretary for further consideration as specified in Article VI of the Constitution and Article XX of the By-Laws.

SECTION 9. *Code of Principles of Conduct Committee.*—A Committee on Code of Principles of Conduct consisting of five members comprising a Chairman (member of the Board of Directors) and four additional members. In addition to the function of formulating and administering a Code, it shall be the duty of the Committee to advise inquirers regarding questions of proper conduct and to examine into and investigate any practice of any member of this Society which shall be regarded as prejudicial to the welfare of the Society, and report its actions and recommendations to the Board of Directors, which shall take such action as it may deem proper.

SECTION 10. *Technical Activities Committee.*—A Technical Activities Committee which shall consist of the Chairmen of all the Technical Committees of the Society and not more than three members-at-large to be appointed by the President. It shall have a Chairman and a Vice-Chairman, who shall be members of the Society and shall be elected by the Committee's membership, but not necessarily from its own ranks. These officers shall serve for a period of two years. The Technical Secretary of the Society shall be the Secretary of this Committee. The Chairman and the Secretary shall be, ex-officio, members of the National Executive Committee without the right to vote. The scope of this Committee shall be: to promote the standardization and technical activities of the Society; to develop the policy, scope and organization of such activities and to supervise their execution; to develop methods and means of cooperating with other standardization bodies, including the nomination of official representatives of the Society on technical committees of other societies or standardization bodies; to pass upon recommended practices, standards and codes with respect to compliance with prescribed procedure and regulations; to decide questions of jurisdiction of Technical Committees; to review (at the Annual Meeting of the Society) the progress of the Society's standardization work; and to act in an advisory capacity to the Board of Directors in respect to standardization programs.

SECTION 11. *Technical Committees.*—Technical Committees, not limited in number, the duty of each of which shall be: to establish an organization; to recommend the scope of its work and its committee membership; to prepare and recommend the acceptance or withdrawal of standards and revisions thereof within its jurisdiction; to report conflicts of jurisdiction to the Technical Activities Committee; to report on the progress of its work; and to carry out such other activities as may be approved by the Technical Activities Committee. Technical Committees shall operate according to the latest revision of "Rules to Govern Organization, Functions and Operations of Technical Committees of the American Welding Society."

SECTION 12. *Educational Committee.*—An Educational Committee whose duties shall be to stimulate and promote educational activities pursuant to the aims and purposes of the Society.

SECTION 13. *Committee on Awards.*—A Committee on Awards consisting of five members each serving for a period of five years, one member retiring each year. The member senior in respect to service shall be Chairman. It shall be the duty of this Committee to make the awards and nominate those to present honorary lectures at the Annual Meeting and to arrange for the presentation of such medals, certificates or other awards as may be authorized by the Board of Directors.

SECTION 14. *Committee on Permanent Funds.*—A Committee on Permanent Funds consisting of five members, each serving for five years, and the Treasurer of the Society, ex-officio. One member shall retire each year. The member senior in respect to service shall be Chairman.

Funds turned over to this Committee by the Board of Directors shall be in its custody for safe-keeping, investment or reinvestment. All acts of the Committee shall require the favorable vote of at least four members of the Committee.

No disbursement shall be made from these funds except upon a favorable vote of at least two-thirds of those present at a meeting of the Board of Directors called for that purpose at which a quorum is present.

A notice of the meeting shall be sent to each member of the Board of Directors at least two weeks prior to the date set for the meeting. The notice shall set forth the reason why the disbursement is proposed.

The Committee shall keep full and accurate accounts of receipts and disbursements in books belonging to the Society, and shall render a financial statement to the Board of Directors annually, or more often if requested.

SECTION 15. *Public Relations Committee.*—A Public Relations Committee which shall handle the relations of the Society to the public, exclusive of the functions assigned to the Publicity Committee. This shall include dealing with all State and Federal legislative matters affecting the Society and the art of welding, particularly those involving welding codes and other proposals which the Committee believes should be considered in order to insure the best interests of the welding art.

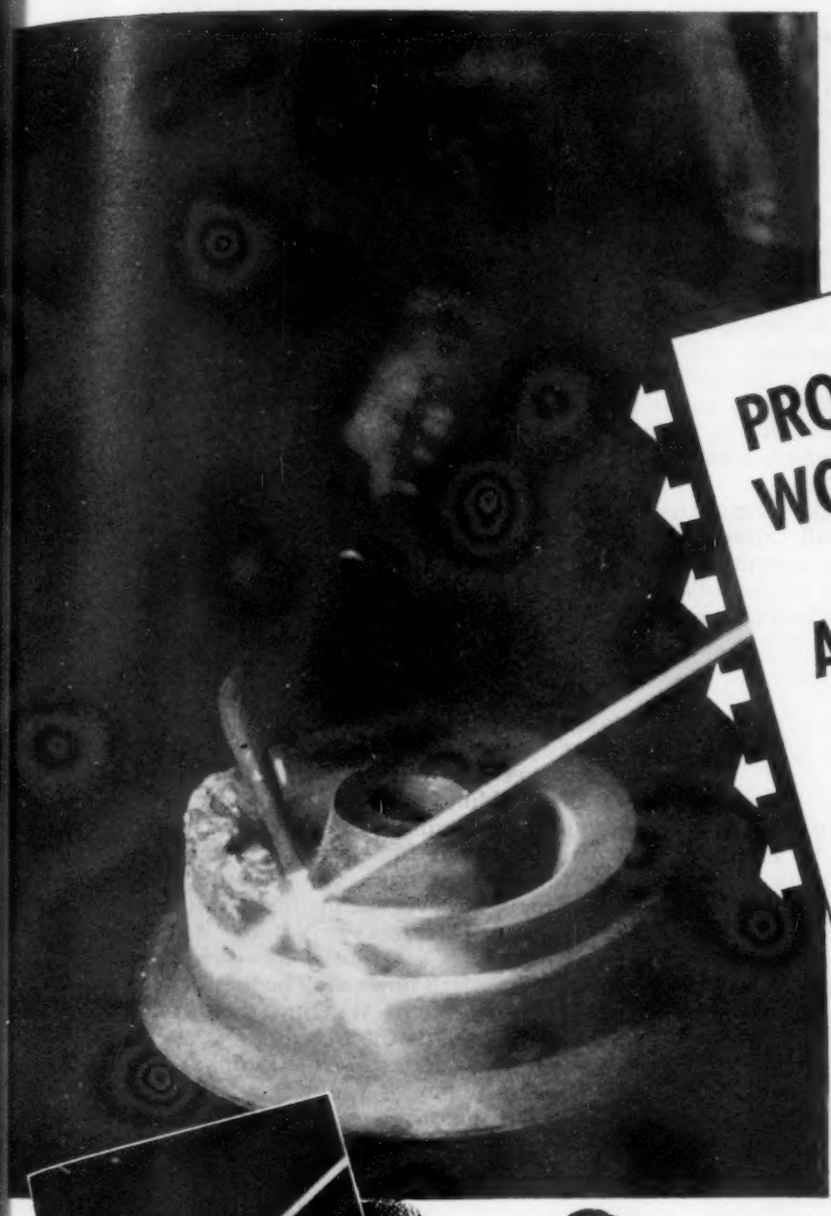
SECTION 16. *Publicity Committee.*—A Publicity Committee which shall establish the publicity policy of the Society, develop the type of program necessary to effectuate this policy and supervise its execution.

SECTION 17. *Convention Committee.*—A Convention Committee comprising a General Chairman, a Vice-Chairman, who shall be either the Chairman of the Local Section where the meeting will be held or someone designated by that Section, the Secretary and Treasurer of the Society, the Chairman of the Manufacturers Committee, the Chairman and Secretary of the Program Committee, the Chairman of the Publicity Committee and the Secretary of the local Section where the meeting will be held. This Committee shall plan and make arrangements (other than those specifically assigned to other committees) and shall correlate activities dealing with Conventions and Exhibitions.

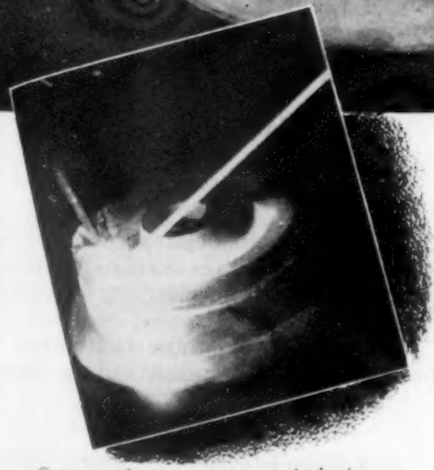
SECTION 18. *Manufacturers Committee.*—A Manufacturers Committee comprised of representatives of manufacturers of welding equipment and supplies, which Committee shall cooperate with the Convention Committee in making arrangements for exhibitions and shall handle matters of general interest to the manufacturers.

SECTION 19. *Section Advisory Committee.*—A Section Advisory Committee, the membership of which shall be composed of the District Vice-Presidents, to act in an advisory capacity to the Board of Directors in all matters pertaining to the activities of the Sections of the Society and to be responsible for planning and conducting Section Officers Conferences. The Chairman shall be designated by the President with the approval of the Board of Directors.

SECTION 20. *Special Committees.*—Additional com-



PROTECT YOUR WORKERS' EYES WITH AO NOVIWELD-DIDYMIUM GLASS



Compare these two unretouched pictures. The one at the top, taken through Noviweld-Didymium, shows how these remarkable lenses give a welder a clearer view of his work, let him do a better job and increase his output.

The bottom picture is taken through standard welding glass.

Speed up Your Production ... Reduce Costs

AO Noviweld-Didymium Lenses enable the welder to look right through cloudy yellow sodium flare, and see the rod and molten area clearly with full protection against the dangerous hazards of ultra-violet and infra-red rays.

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Right now, you can get immediate delivery of Noviweld-Didymium for the welding goggles of *all* of your operators in shade numbers 3, 4, 5, and 6. Phone or write your nearest AO Branch Office.

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mittees may be appointed for a definite stated purpose or purposes.

SECTION 21. *Proposed Committees.*—A Committee or Committees for a definite stated purpose or purposes may be proposed by any member of the Society in good standing, together with the personnel of such Committee or Committees, but the final selection of the personnel must be by a majority vote at one of the meetings of the Society as set forth under Article XI, Sections 1 and 2, provided the necessary quorum, per Article XI, Section 5, is present and further provided that definite notice stating all purposes and objectives of such committee or committees shall have been sent to each member, and/or published in THE WELDING JOURNAL of the AMERICAN WELDING SOCIETY for the preceding month, so as to reach the membership at least two weeks prior to said meeting at which the Committee or Committees will be proposed and elected.

SECTION 22. *Term of Committees.*—All Committee appointments not otherwise specified shall expire with the Society Year. Technical Committee appointments shall be governed by "Rules to Govern Organization, Functions and Operations of Technical Committees of the AMERICAN WELDING SOCIETY."

ARTICLE XIII

Voting and Proxy

SECTION 1. *Voting.*—Each Corporate Member as described in Article I, Section 3, shall be entitled to vote on all questions presented by the Society or by the Section to which the member belongs. Voting may be in person or by proxy.

SECTION 2. *Voting by Proxy.*—Voting by proxy shall not be allowed at any meeting of the Society or its Board of Directors or of any of its Committees except by personal representative consisting of a member of the particular group or Committee, presenting written credentials at the particular meeting stated, and covering only those matters clearly stated on the face of the proxy. All proxies must be in writing and must be delivered to the Secretary of the meeting, at which they are to be voted, prior to the opening hour of the meeting.

ARTICLE XIV

Publications

SECTION 1. *The Welding Journal.*—(*a*) The Society shall publish a magazine to be known as "THE WELDING JOURNAL of the AMERICAN WELDING SOCIETY." It shall contain technical papers, Welding Society news and information of interest to the members of the AMERICAN WELDING SOCIETY. (A separate section may be used for the publications of the Welding Research Council; see Article XV, Section 4.)

(*b*) THE WELDING JOURNAL shall be sent to each member of the Society, in good standing.

SECTION 2. *Year Book.*—A Year Book shall be published annually, or at such times as approved by the Board of Directors. It shall include the Constitution and By-Laws of the Society; list of committees and their membership; Alphabetical and Geographical List of Members; a financial statement and other data of interest to the membership of the Society.

SECTION 3. *Codes and Specifications.*—The Society reserves the right or privilege of publishing as an AMERICAN WELDING SOCIETY Standard any code, specification or standard prepared by its committees, either jointly or in cooperation with another Society or other Societies, Associations or regulatory bodies.

SECTION 4. *Responsibility for Statements.*—The Society shall not be responsible for statements or opinions advanced in papers or in discussion at meetings of the Society or of its Sections or Districts, or printed in its publications.

SECTION 5. *Copyright.*—The Society reserves the right to copyright, at the discretion of the Board of Directors any of its papers, discussions, reports or publications.

SECTION 6. *Use of Society Name or Emblem.*—Unless approved by the Board of Directors, the name, emblem or initials of the Society shall not be used in any commercial publication or business, except to indicate conformity with its standards, or recommended practices.

ARTICLE XV

Welding Research

SECTION 1. *Welding Research Council.*—The AMERICAN WELDING SOCIETY shall provide the means for cooperative research in welding by creating or joining in the creation of a research department to be known as the Welding Research Council. Other societies, associations and government departments may be asked to assist in this work.

SECTION 2. *Research Funds.*—Funds for the work of the Welding Research Council shall be secured by voluntary contributions, by solicitation or appropriated from the regular funds of the Society. Solicitation of any funds in the name of the AMERICAN WELDING SOCIETY may, however, be made only with the approval of the Board of Directors.

SECTION 3. *Custodian of Research Funds.*—The Custodian of research funds shall be the Engineering Foundation, the AMERICAN WELDING SOCIETY, or any other body designated by the Board of Directors.

SECTION 4. *Research Publications.*—A separate section of THE WELDING JOURNAL of the AMERICAN WELDING Society may be created for the publications of the Welding Research Council.

ARTICLE XVI

Audit and Finance

SECTION 1. *Audit.*—The financial accounts of the Society shall be audited annually previous to the Annual Meeting, by a Certified Public Accountant, selected by the Board of Directors.

SECTION 2. *Bonds.*—One of those authorized to sign checks and other financial documents of the Society shall be bonded.

ARTICLE XVII

Fiscal Year

SECTION 1. The fiscal year of the Society shall commence on October 1st and end September 30th.

ARTICLE XVIII

Permanent Office

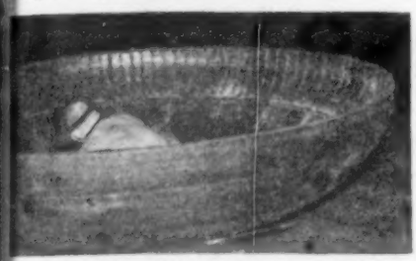
SECTION 1. A permanent office of the Society shall be maintained in the City of New York and shall be lo-

STRONG, SOUND WELDS

. . . well done!

A typical Monel arc weld made with No. 130X Monel electrode.

Monel is extensively used for lining heat exchanger shells. This steel shell is lined with .078" Monel sheet, arc welded with No. 130X Monel electrode. Photo courtesy of The Lummus Company.



Both plug welding and strip welding are employed for lining fractionating and other steel process equipment with Monel sheet or strip. No. 130X Monel electrodes are used. Photo courtesy of Wyatt Metal & Boiler Works.

No. 130X Monel electrodes are also used for welding Monel Clad steel as in this fractionating tower which is six feet in diameter and 43½ feet in length. The top 15½' section is Monel Clad Steel 22/32" thick with ⅛" of Monel cladding. Manways and covers are lined with ⅛" Monel sheet by plug welding. Photo courtesy of Edge Moor Iron Works, Inc.

* * *

The elbows below were readily fabricated from Monel sheet and then arc welded with No. 130X Monel electrodes. Photo courtesy of Farwell, Ozmun, Kirk & Co.

Electric arc welding with Monel offers several important advantages.

Monel is easily fabricated by methods similar to those used in making quality welds in steel. It may be welded in all positions with the same facility.

Monel's coefficient of expansion is the same as that of steel. This permits steel and Monel to be used on the same job.

Welds are sound and ductile. In addition, they are as strong and as highly resistant to corrosion as the parent metal. No thermal or chemical after treatment is needed to restore the corrosion-resistant qualities of the welded joints.

As indicated in the photographs, No. 130X Monel Arc Welding Electrodes are employed for welding all forms of wrought and cast Monel to Monel, or Monel to steel.

Engineering data, working instructions, and helpful information on welding procedures are contained in Bulletin T-2, *Welding, Brazing and Soft Soldering of Monel, Nickel and Inconel.* A copy of this well-illustrated, 32-page bulletin will be sent on request.

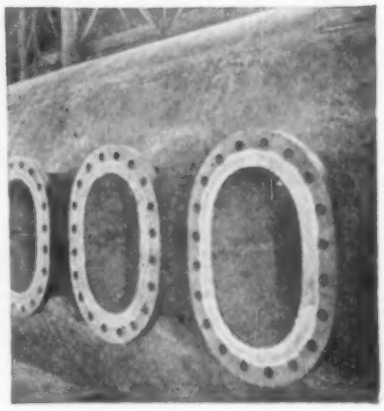
THE INTERNATIONAL NICKEL COMPANY, INC. • 67 WALL STREET, NEW YORK 5, N. Y.

No. 130X *Monel* ELECTRODES

Large diameter piping may be made either of Lukens Monel Clad steel or of steel lined with Monel sheet as in the Y reducers shown at the left. In either case, No. 130X Monel electrodes are used. Photo courtesy of Robinson Engineering Company.

* * *

The steel bolt circles of these manways are overlaid with Monel by a 2-layer weld of No. 130X Monel electrode. Photo courtesy of Edge Moor Iron Works, Inc.



cated in the Engineering Societies' Building at 25–33 West 39th St., or at such other place as the Board of Directors may determine.

ARTICLE XIX

Parliamentary Rules

SECTION 1. Roberts' "Rules of Order" shall be the governing parliamentary law of the Society in all cases not definitely provided for by its Constitution or its By-Laws or its own rules.

ARTICLE XX

Amendments

SECTION 1. Amendments to these By-Laws may be instigated by petition signed by not less than ten voting members in good standing, or by the Constitution and By-Laws Committee, or by the Board of Directors. Such proposed amendments to become effective must be approved by not less than two-thirds of the Directors present at a meeting regularly called for consideration of same. If approved by the Board of Directors, amendments shall be considered temporary and then shall be published in THE WELDING JOURNAL and not less than 30 days later shall be submitted to the membership for letter ballot. The amendments shall be adopted at the expiration of 60 days after mailing the ballots unless rejected by at least 20 per cent of the voting membership.

RULINGS ADOPTED BY BOARD OF DIRECTORS

April 1920

Section Organization.—The Officers of the Society are authorized to assist in formation of Sections in any part of the United States under the adopted standard form of Constitution with variations to meet local conditions and to grant the necessary authority for the formation of such Sections. When possible, the Sections should be affiliated with the local general engineering society and where practicable, the organization work should be conducted from such society headquarters.

December 1927 (original ruling January 1922)

Delinquents.—A delinquent member shall be supplied with THE WELDING JOURNAL and other literature for the first two months of delinquency but following the second month he shall receive only notices of meetings.

November 1937

Directors' Meetings.—The President is empowered, when in his opinion it is deemed wise, to invite non-members to meetings of either the Board of Directors or Executive Committee.

Voting at Executive Committee meeting is limited to Executive Committee members or their proxies. Members of the Board of Directors are invited to Executive Committee meetings for the purpose of participating in discussion.

July 1938

Establishment of Society Policy on News Items or Radio Broadcasts Detrimental to Welding.—It is preferable for the Society to remain silent until official report dealing with the subject in question has been received.

July 1941

Certification of Welders—Policy Established for Guidance of Public Relations Committee.—Under no condition shall the AMERICAN WELDING SOCIETY issue a Certificate to a welding operator, nor support a plan for the certification of welding operators, that denies a fabricator the privilege of qualifying his own welding operators.

February 1942

Policy on Questions Relating to Labor Organizations.—It is the policy of the AMERICAN WELDING SOCIETY not to render information on questions relating to labor or labor organizations, nor to enter into any controversy that affects these questions.

June 1943

Establishment of Society Policy Regarding Contributions.—It shall be the policy of the Society not to make contributions to charitable and nonprofit membership corporations.

December 1943 (Original ruling July 1941).

Year Book.—Copies of the Year Book will be given only to members requesting them.

December 1943 (Original ruling April 1920)

Powers of Executive Committee.—The Board of Directors delegated to Executive Committee its full power with understanding that Executive Committee will immediately report by letter to every member of the Board any action which it has taken and allow sufficient time for objection to such action before it is put into effect. Should a majority of the Board express objection within 2 weeks to any action, the President will then immediately call a special meeting of the Board and have the matter presented to them for confirmation.

September 1944

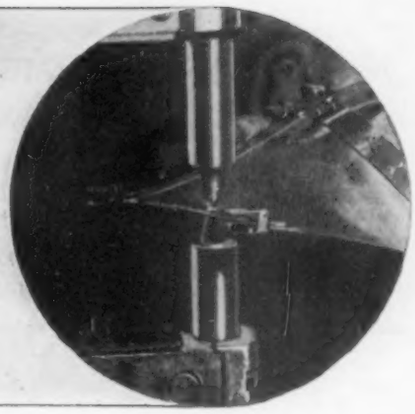
Listing in the Year Book.—There shall be listed in the Year Book, corporations, firms and partnerships who sponsor Sustaining Members, giving a brief account of their products. There shall also be listed separately in the Year Book, corporations, firms and partnerships who pay at least $100.00 per annum in dues for not over seven (7) memberships in the Society, giving a brief account of their products.

All other rulings of the Board of Directors to be rescinded.

Constitution of the American Welding Society

Delete Article VII.

DO'S *and* DON'TS
for
Resistance Welding Electrodes and Holders



Do's

1. Use the proper electrode material for the job you are doing.
2. Use standard electrodes wherever possible.
3. Use the most suitable tip diameter for the thickness of stock being welded.
4. Use open sight drains to observe more readily the water flow through holders.
5. Connect the water inlet hose to the proper holder inlet so that water flows through the center cooling tube first.
6. Internally cool spot welding tips with cool water flowing at a rate of at least 1½ gals. per minute through each tip.
7. Be sure that the internal water cooling tube of the holder projects into the tip water hole to within ½" of the tip hole bottom.
8. Adjust the internal water cooling tube of the holder to the proper height when changing to a different length tip.
9. Be sure top of adjustable water cooling tube in holder is cut at an angle to avoid jamming tip down and shutting water off.
10. Place a thin film of cup grease on the tip taper prior to inserting it in the holder, to make it easier to remove.
11. Use ejector type holders for easy removal of tips and to avoid damage to tip walls.
12. Keep the tip taper and holder taper clean, smooth and free from foreign deposits.
13. Dress spot welding electrodes often enough to maintain the quality of welds.
14. Dress electrodes in a lathe to their original contour whenever possible.
15. Use a rawhide or rubber mallet for striking holder or tips in aligning operations.
16. Provide flood cooling on both sides of the seam welding wheel.
17. Use properly designed knurling wheels to maintain proper seam welding wheel shape.

Don'ts

1. Never use unidentified electrodes or electrode materials.
2. Avoid special, offset or irregular tips when the job can be done with a standard straight tip.
3. Don't use small tips on heavy gauge welding jobs, or large tips on small work.
4. Don't forget to turn on the cooling water full force before starting to weld.
5. Never use water hose that will not fit the holder water connection nipples snugly.
6. Do not allow water connections to become leaky, clogged or broken.
7. Avoid using holders with leaking or deformed tapers.
8. Never use electrode holders that do not have an adjustable internal water cooling tube.
9. Do not permit adjustable water tube to be "frozen" by accumulation of deposits. A few drops of oil periodically will keep the tube free.
10. Do not allow electrodes to remain idle in tapered holder seats for extended periods.
11. Don't use pipe wrenches or similar tools in removing electrodes.
12. Avoid using white lead or similar compounds to seal a leaking taper.
13. Never permit a spot welding tip to mushroom enough to make dressing difficult.
14. Never dress electrodes with a coarse file.
15. Don't pound on holder or tip with a steel hammer in aligning the welder arms.
16. Avoid the use of seam welder wheels too thin to stand the heat or pressure of your job.
17. Do not permit seam welding wheel to run off the corners of the work being welded.

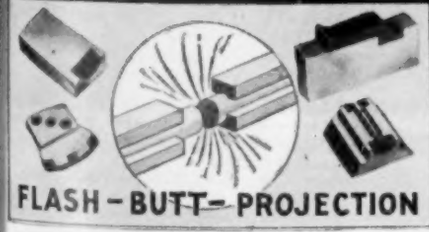
DO obtain higher output by using Mallory Standard Resistance Welding Electrodes—Spot Welding Tips and Holders. Consult us for seam welding wheels and flash, butt and projection welding dies for your particular application. Write on your company letterhead for your copy of the electrode catalog and the Mallory Resistance Welding Data Book.

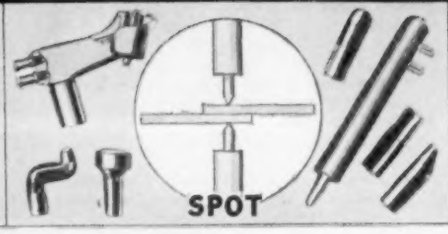
One of a series—the entire series mailed at your request.

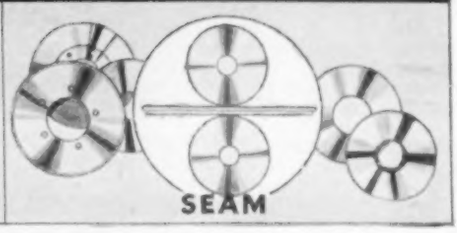
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

P. R. MALLORY & CO. Inc

MALLORY *Standard Resistance Welding Electrodes*







Sections—CHAIRMEN, SECRETARIES, AND REGULAR MEETING DATES

ATLANTA — 1st Fri.
SECRETARY—J. V. TURNER, Air Reduction Sales Co., 336 Spring St., N. W., Atlanta, Ga.

BIRMINGHAM — 1st Thurs.
CHAIRMAN—W. B. Browning, The Linde Air Products, 1001-13 So. 22nd St., Birmingham, Ala.
SECRETARY-TREASURER—W. L. POOLE, Air Reduction Sales Co., 2825 N. 29th Ave., Birmingham, Ala.

BOSTON — 2nd Mon.
CHAIRMAN—F. W. DAVIS, E. B. Badger & Sons Co., 75 Pitts St., Boston, Mass.
SECRETARY—P. N. RUGG, 22 Eastern Ave., Wakefield, Mass.

BRIDGEPORT
CHAIRMAN—N. B. GILLILAND, 4883 North Main St., Stratford, Conn.
SECRETARY—C. PARKS, The Bullard Co., 286 Canfield Ave., Bridgeport 2, Conn.

BRUNSWICK, GA.
CHAIRMAN—W. A. PIERRE, JR., J. A. Jones Const. Co., Brunswick, Ga.
SECRETARY—W. P. BOLEN, 1303 Dartmouth St., Brunswick, Ga.

CANAL ZONE — 1st Tues.
CHAIRMAN—CLIFFORD B. JONES, Box 533 Diablo Heights, Canal Zone
SECRETARY—JAMES G. MURRAY, Panama Canal, P. O. Box 623, Diablo Heights, Canal Zone

CHATTANOOGA, TENN. — 1st Wed.
CHAIRMAN—JUSTIN BROWN, Chattanooga Boiler Tank Co., 1011 E. Main St., Chattanooga, Tenn.
SECRETARY-TREAS.—R. G. WILSON, 1329 Chestnut St., Chattanooga 2, Tenn.

CHICAGO — 3rd Fri.
CHAIRMAN—C. L. PFEIFFER, 316½ N. Menard Ave., Chicago, Ill.
SECRETARY—T. B. JEFFERSON, *The Welding Engineer*, 506 S. Wabash Ave., Chicago, Ill.

CINCINNATI, OHIO
CHAIRMAN—GEORGE A. JACOBY, 1743 S. Derexa Dr., Hamilton, Ohio
SECRETARY—L. E. SHERMAN, Box 183, Lockland P. O., Cincinnati, 15, Ohio

CLEVELAND — 2nd Wed.
CHAIRMAN—ROSS J. YARROW, Republic Structural Iron Works, 1290 E. 53rd St., Cleveland, Ohio
SECRETARY-TREAS.—A. LESLIE PFEIL, Universal Power Corp., Cleveland, Ohio

COLUMBUS, OHIO — 2nd Fri.
CHAIRMAN—L. P. WOOD, Curtiss-Wright Corp., 4300 E. 5th Ave., Columbus 16, Ohio
SECRETARY—G. S. HERREN, The Seagrave Corp., Columbus, Ohio

DETROIT — 1st Fri.
CHAIRMAN—HENRY C. NEITZEL, Whitehead & Kales Co., 58 Haltiner, Detroit 18, Mich.
SECRETARY—G. N. SIEGER, S-M-S Corp., 1165 Harper Ave., Detroit, Mich.

HARTFORD
CHAIRMAN—JOHN W. MORTIMER, The Whitelock Mfg. Co., P. O. Drawer 390, Hartford, Conn.
SECRETARY—R. H. FLORIAN, Trumbull Electric Mfg. Co., Plainville, Conn.

HAWAII — Last Thurs.
CHAIRMAN—GEORGE GLOVER, W. A. Ramsay, Ltd., Honolulu, T. H.
SECRETARY—ALAN G. SLIPPER, Hawaiian Gas Products Co., P. O. Box 2454, Honolulu, T. H.

INDIANA — 3rd Fri.
CHAIRMAN—J. R. WIRT, Process Dept. Delco-Remy Div., Gen. Motors Corp., Anderson, Ind.
SECRETARY—MRS. MERCEDES SPOTTS, P. R. Mallory Co., Indianapolis, Ind.

KANSAS CITY, MO. — 1st Tues.
CHAIRMAN—DUANE DE BRUNNER, Columbian Steel Tank Cor., 1509 W. 12th St., Kansas City, Mo.
SECRETARY—A. C. SLUSS, Moore Company, 556 Westport Road, Kansas City, Mo.

LAKE SHORE
CHAIRMAN—FRED HERBST, JR., McMullen & Pitz Construction Co., 923 Commercial St., Manitowoc, Wis.

LEHIGH VALLEY
CHAIRMAN—J. W. KENWORTHY, 113 N. 11th St., Allentown, Pa.
SECRETARY—JULIUS NAAB, Ingersoll-Rand Co., Phillipsburg, N. J.

LOS ANGELES — 3rd Thurs.
CHAIRMAN—CHARLES A. BABBITT, Western Pipe & Steel Co., 5717 Santa Fe Ave., Los Angeles, Calif.
SECRETARY—E. O. WILLIAMS, Victor Equipment Co., Los Angeles, Calif.

LOUISVILLE — Last Tues.
CHAIRMAN—THEODORE H. LEWIS, Jeffersonville Boat & Machinery Co., Louisville, Ky.
SECRETARY—R. L. HACHSTRASSER, Joseph W. Greathouse Co., 530 River Road, Louisville 2, Ky.

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CHAIRMAN—J. C. CUMBERLAND, Lexington Bldg., Room 1000, Baltimore, Md.
SECRETARY-TREAS.—W. H. SHAFROW, 3806 Ednor Road, Baltimore, Md.

MILWAUKEE — 3rd Fri.
CHAIRMAN—CARL MALMBERG, 555 Elm Spring Ave., Wauwatosa, Wis.
SECRETARY—CHAUNCY HART, Heil Co., 300 W. Montana St., Milwaukee

MOBILE
CHAIRMAN—REYNOLD ALONZO, Rt. 3, Box 24, Stanton Rd., Mobile, Ala.
SECRETARY-TREAS.—W. E. KELLY, 1561 Luling St., Mobile, Ala.

NEW JERSEY — 3rd Tues.
CHAIRMAN—G. N. NIGH, Tidewater Associated Oil Co., Bayonne, N. J.
SECRETARY—P. N. MATTERN, Wilson Welder & Metals Co., 60 E. 42nd St., New York 17, N. Y.

NEW YORK — 2nd Tues.
CHAIRMAN—G. V. SLOTTMAN, Air Reduction Sales Co., 60 E. 42nd St., New York 17, N. Y.
SECRETARY—GEORGE SYKES, The Linde Air Products Co., General Publicity Dept., 30 E. 42nd St., New York, N. Y.

NORTHERN NEW YORK — Last Thurs.
CHAIRMAN—H. S. SWAN, American Locomotive Co., Nott St., 5 Story Bldg., Schenectady, N. Y.
SECRETARY—R. S. PELTON, General Electric Co., Schenectady, N. Y.

NORTHWEST — 3rd Wed.
CHAIRMAN—C. M. UNDERWOOD, Northern Pump Co., Minneapolis, Minn.
SECRETARY—ALEXIS CASWELL, Manufacturers' Assoc. of Minn., 200 Builders Exchange Bldg., Minneapolis, Minn.

OKLAHOMA CITY — First Thurs.
CHAIRMAN—H. N. SIMMS, 1217 S. W. 32, Oklahoma City, Okla.
SECRETARY—J. M. MIDKER, 100 E. Main St., Oklahoma City 2, Okla.

PASCAGOULA
CHAIRMAN—W. B. BOWEN, The Ingalls Shipbuilding Corp., P. O. Box 149, Pascagoula, Miss.
SECRETARY-TREAS.—MILTON FORMAN, 1012 Cherubusco St., Pascagoula, Miss.

PEORIA—CENTRAL ILLINOIS — 3rd Wed.
CHAIRMAN—WALTER J. BROOKING, R. G. Le Tourneau, Inc., Peoria, Ill.
SECRETARY—HAROLD BALDWIN, R. G. Le Tourneau, Inc., Peoria, Ill.

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CHAIRMAN—G. R. JOHNSON, The Lincoln Electric Co., 401 N. Broad St., Philadelphia 8, Pa.
SECRETARY—K. W. OSTROM, 213 Glen Gary Dr., Westgate Hills, Upper Darby P.O., Pa.

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CHAIRMAN—C. H. JENNINGS, Westinghouse Elec. & Mfg. Co., Pittsburgh, Pa.
SECRETARY—J. F. MINNOTTE, Minnotte Bros. Co., 1201 House Bldg., Hays (7) Pittsburgh, Pa.

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CHAIRMAN—A. R. SCHWERDTFEGER, 30 Richland St., So. Portland, Me.
SECRETARY-TREAS.—LEONARD W. COOPER, Falmouth Foreside, Town Landing, Portland, Me.

PORTLAND ORE.
CHAIRMAN—E. L. HANN, 940 S. E. 7th Ave., Portland, Ore.
SECRETARY—PAUL KULLBERG, Industrial Specialties Co., 940 S. E. 7th Ave., Portland 14, Ore.

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SECRETARY—J. BARR, Todd Pacific Shipyard, Seattle, Wash.

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SECRETARY—EDWARD R. JONES, Allen Iron & Welding Wks., 133 Murray St., Rochester 6, N. Y.

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CHAIRMAN—C. F. DOGGETT, Moore Dry Dock Co., Ft. Adeline St., Oakland, Calif.
SECRETARY—R. E. LABAGH, Victor Equipment Co., 844 Folsom St., San Francisco, Calif.

ST. LOUIS — 2nd Fri.
CHAIRMAN—W. S. EVANS, 789 Glen Vista, Glendale, Mo.
SECRETARY—H. C. CLOSE, Machinery & Welder Corp., 700 S. Spring Ave., St. Louis, Mo.

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SECRETARY-TREAS.—A. E. WISLER, Hughes Tool Company, 300 Hughes St., Houston, Texas

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SECRETARY—J. HOTCHKISS, 1590 Westmoreland Ave., Syracuse 10, N. Y.

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CHAIRMAN—C. O. BARHAM, 1501 Lansing Ave., Portsmouth, Va.
SECRETARY-TREAS.—E. C. ROWELL, 118 Oregon Ave., Portsmouth, Va.

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SECRETARY—LLOYD BERSTICKER, 4234 Templer Road, Toledo 12, Ohio

TULSA, OKLA.
SECRETARY—JAMES B. DAVIS, Tulsa Testing Labs., Tulsa, Okla.

WASHINGTON, D. C. — 2nd Tues.
CHAIRMAN—C. E. JACKSON, Naval Research Lab., Washington 20, D. C.
SECRETARY—G. G. LUTHER, Naval Research Lab., Anacostia Station, Washington, D. C.

WESTERN MASSACHUSETTS — Last Mon.
CHAIRMAN—EMIL STOLTE, Westinghouse Elect. & Mfg. Co., 653 Page Blvd., Springfield 2, Mass.
SECRETARY—E. J. PELTIER, Westinghouse Elect. & Mfg. Co., 653 Page Blvd., Springfield 2, Mass.

WESTERN MICHIGAN
CHAIRMAN—W. J. ELBROOKE, Haven-Busch Co., 501 Front, N. W., Grand Rapids, Mich.
SECRETARY—R. D. LAYMAN, The Lincoln Electric Co., 200 Division Ave., Grand Rapids 2, Mich.

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SECRETARY—R. S. LANE, Ross Heater & Mfg. Co., 1407 West Ave., Buffalo, N. Y.

WICHITA, KAN. — 3rd Wed.
CHAIRMAN—R. W. TOWNSEND, 266 South Minneapolis, Wichita, Kan.
SECRETARY—M. L. LAMPTON, 2312 N. Minnesota, Wichita, Kans.

YORK—CENTRAL PA. — 2nd Wed.
CHAIRMAN—C. E. LEWIS KERCHNER, R. D. No. 1, Thomasville, Pa.
SECRETARY—PAUL DRESSEL, Dressel Spring Works, 325 Prospect St., York, Pa.

YOUNGSTOWN, OHIO — 2nd Mon.
CHAIRMAN—ARTHUR W. WALDO, Youngstown Welding & Eng. Co., 3700 Oakland Ave., Youngstown, Ohio
SECRETARY—H. ROSS STROHECKER, Youngstown Welding & Eng. Co., Youngstown, Ohio